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INVESTIGATION BY THE SOCIETY.

BY GEORGE B. PEGRAM,

President of the Society.

This summer the country has had before it the dramatized spectacle of one of those recurring clashes between zealous upholders of a certain interpretation of the Christian religion and others who would follow the methods and hold to the theories of national scientific inquiry. This clash is of precisely the same nature as that of three centuries ago, when a certain Galileo was put in prison because his heliocentric theory was most honestly believed by those in authority to contradict the truth as explicitly set forth in the holy scriptures. The whole episode of 1925, with the heat of feeling, the intolerance in views and intemperance in expression exhibited in it is probably of no more importance to the progress of either science or religion than was the short imprisonment of the recanting Galileo. It is, however, a notable illustration of the fact that violent feeling and immoderate speech arise most easily with those who find themselves supporting tenets into the basis of which they fear to examine or for which they realize the proof to be inadequate.

Fortunately it is mainly by way of contrast that the Tennessee-Miami-Chicago exhibition is referred to in connection with engineering education, yet if recollection serves rightly, it is a fact that some years ago discussion of engineering education at the meetings of the Society for the Promotion of Engineering Education, and in other groups, was characterized by more fervidly expressed views and counterviews, and more drastic proposals as to what should be done about this or that than seem likely to be brought forward just now in the Society. On the other hand, the recent meetings of the Society have been remarkable for the general attitude of careful study, impassionate discussion and appreciative ex-

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change of experience, which is a natural result of the concerted objective study of engineering education now in progress. At the Schenectady meeting the mass of information as to facts collected by the committees of the engineering schools and reported from the office of the Director of Investigations, so challenged analysis; and the review presented by the several committees and by the Director and by the Associate Director, showed such good balance that there resulted no warmth of discussion. Instead of offhand discussion there was evidenced a great concentration of interest on the information now in hand and a disposition to study it carefully before presuming to discuss its significance. As a single example of how we are passing from the exciting ground of pious assertion to the calmer region of proof, it may be cited that a short time ago when it was claimed by some that engineering students came from an inferior stratum of high-school graduates, we could only rush to their defense by strong assertion of our belief to the contrary. Now with the report of the Committee on Entering Students before us, we can calmly show the proof that engineering students as a group come from quite the upper portion of our high-school graduates.

Similarly many other questions that have in the past been subjects of earnest views and of warm debate, will, through the present investigation, really be answered and the answer will become part of the common knowledge of those informed on engineering education. But there will always be unsettled and debatable subjects in plenty, to which it will be possible to apply in discussion all the ardor of adherence to tradition or to intuition, and one might say that our difficulties have only been pushed further along.

Getting ahead to the next problem is, in one sense, all there is to progress, but the gain of our present progress lies deeper than simply attaining definite knowledge up to a certain point. The great gain is the advance in method that has been achieved. It is hardly to be thought that the membership of this Society and the institutions represented in it, can ever give up the method of concerted and coöperative study of our

problems of engineering education and relapse to the sporadic studies and the exchange of plausible opinion that were the best that could be done before the Board of Investigation and Coördination came into being. It is the chief immediate responsibility of those charged with directing the activities of the Society to conserve this great gain in method and to take advantage of all its results.

THE ENGINEERING COLLEGE—ITS OPPORTUNITY FOR SERVICE.*

BY A. A. POTTER,

Dean of The Schools of Engineering, Purdue University.

This, the thirty-third annual meeting of this Society for the Promotion of Engineering Education marks the beginning of the second century of engineering education in English-speaking countries. It is fitting for us to reflect on past achievements and to plan for the future of engineering education. It is well for us constantly to subject our work to the acid test of critical examination with the hope that such an analysis will result in improvements which will meet the new demands of a new day.

General Interest in Engineering Education.—President Samuel M. Vauclain of the Baldwin Locomotive Works has recently remarked that "Education has been the life blood of this nation." It has always been our American faith that an educated electorate is the corner stone of a successful democracy. Premier Mussolini in a recent address at the University of Padua lays it down as a fundamental principle of all successful government that: "As long as there are schools and universities and young men to attend them the world is safe." It is estimated that one out of every four persons in the U. S. A. is now directly concerned with education, either as pupil, teacher, or educational administrator. That our American faith in education is still undimmed is demonstrated by fact that the total money expended for educational purposes has been increased more than three-fold during the past ten years.

* Presidential Address delivered at the thirty-third annual meeting of the Society for the Promotion of Engineering Education at Schenectady, New York, June 19, 1925.

The rapid growth in the number and in the enrollment of the engineering colleges in the United States of America during recent years is in part an indication that there has been public approval of the type of education offered by these institutions. Conditions in this country have also been particularly favorable to engineering education because of our unusual natural resources and of the rapid growth of our industries which are dependent upon men who are properly prepared.

Engineering and Human Welfare.—Engineering strives to provide better and easier ways of satisfying human needs. During the last twenty-five years science and engineering have richly contributed to human welfare by elevating social conditions and improving standards of living. If our people are more prosperous, more comfortable, and more happy because of the use of mechanical power and machine-made products; because of the abridgment of distance through modern transportation facilities; because of the ease of communicating with others by means of the telegraph, telephone, and radio; because of the developments of the electric light, artificial gas, the X-ray, the moving pictures, and the talking machine; because of adequate water supply, safer sanitary arrangements, better buildings, streets, and roads;—if for these reasons life is now better worth the living than ever before—it is because scientists, inventors, and engineers have for a generation been working quietly, persistently, and systematically to confer these benefits on mankind as their contribution to the economic progress of human society.

President Coolidge's remarks before the American Association for the Advancement of Science apply to engineers and scientists alike: "The future of civilization is well-nigh in your hands. You are the wonder workers of all ages. Those of us who represent social organization and political institutions look upon you with a feeling that includes much of awe and something of fear, as we ask ourselves to what revolution you will next require us to adapt our scheme of human rela-

tions. But we know you are animated by a profound purpose to better the estate of men."

Industry and Engineering Colleges are Interdependent.—The development of the engineering college in type, in size, and in effectiveness has followed very closely upon the progress of science and industry. Industry has not made the engineering college nor is the engineering college alone responsible for the progress in the material content of our civilization. The two are interdependent. The growth or the improvement in the one affects the other and neither could have attained its present importance without the aid of the other. Industry is dependent upon the engineering colleges for supply of men who have a scientific and technological foundation and for leaders who have the training and talent to explore new fields. The engineering colleges are dependent upon industry to keep their instruction abreast with the times and their research activities practical and effective. Industry and the engineering colleges can justly share the credit for our progress during the past fifty years and should plan together for further advancement.

Outstanding Characteristics of Engineering Colleges.—The interest of engineering colleges has hitherto centered in undergraduate instruction. An effort has been made to train the student for largest ultimate development and for greatest usefulness in the long run. The engineering colleges have not attempted to turn out a finished product, but to graduate men with capacity to become engineers. They have trained students in the rational solution of problems by building the engineering curricula upon a mathematical and scientific foundation. Mathematics, science, mechanics, and the fundamentals of engineering were used to develop reasoning power and the ability to arrive at truth by observation and by experiment. The importance of facts and the responsibility of the engineer for accurate results have been constantly stressed. Engineering educators have successfully warded off all attempts to lower the rigidity of the engineering courses of study, and have concentrated upon subjects which the student cannot well

acquire by his own efforts and which he cannot master without hard work. The providing of a background of engineering knowledge has always been subordinated to the training of the mind.

Contrary to the popular impression, engineering curricula are not highly specialized. "American engineering students receive very little less than two years of work which would be entirely acceptable toward a degree in practically any college of arts and sciences" is the conclusion of Mr. W. E. Wickenden, Director of Investigations for this Society, after a thorough examination of the present curricula of engineering colleges.

The major portion of the students' time is devoted to fundamental subjects which include: Mathematics, science, mechanics, thermodynamics, theoretical electricity, and the principles of engineering. The policy of engineering colleges has been to give an important place to studies which develop in students the ability to understand and to interpret correctly the ideas of others as well as the capacity for clear logical thinking and clarity of expression on their own part.

It is very doubtful if radical changes are necessary in the present engineering curricula. It is the duty of the faculty of every engineering college to analyze curricula most critically, to condense to a practical minimum all descriptive and specialized courses, and to improve the quality of instruction. In studying engineering curricula it may be well to question as to whether the initiative and reliance of our students are not sacrificed by too much prescribed study or by too strict adherence to text books.

Engineering is a profession in which errors are always serious. The late President Roosevelt stated "We don't know what thoroughness is." Our present civilization is constantly bidding higher for men of great ability and thorough training. In planning for the training of the engineers of the future, engineering educators will be called upon to make a greater effort to emphasize thoroughness.

The gospel of quality and not of quantity should guide us

in revising our courses of study, as it is certain that the superficial acquaintance with many subjects is less valuable than the complete mastery of a few. There is always the danger of including too many subjects in college curricula, with the result that thoroughness will be sacrificed and the student will learn subject matter and not independent thinking. In engineering education every means must be employed to counteract this tendency while developing the power of analysis and awakening the creative genius of the student.

Technique of Engineering Education.—At the 21st Meeting of this Society Professor W. T. Magruder in his presidential address on the "Good Engineering Teacher" brought out that the master teacher among many other qualities "is one who knows enough of his subject to have something to impart, is something of a scholar, student and creator, has unbounded enthusiasm for the work of the teacher and engineer, is of inspirational value to his students, and highest of all is an educator capable of leading others to be the same."

The supply of high grade engineering teachers has not kept pace with the growth in the enrollment of our engineering colleges. In order to improve or even to retain our present standards more attention will have to be given in the future to professional training in engineering education. While two teachers, using the same teaching methods and the same text books may produce entirely different results, the fact remains that a knowledge of psychology and of technique of education is of particular value to the young teacher. Much valuable time is lost because engineering teachers frequently lose themselves in the ramification of the subject matter and without regard to the student's aptitudes. More knowledge of the technique of teaching should reduce poor teaching and hasten the development of the instructor.

"There is no royal road to learning." It involves hard laborious study. But observation shows that few high school graduates know how to study effectively. Will not the instruction of the engineering colleges be more effective when we devote more attention to the habits of work of our engi-

neering students and give systematic instruction in methods of study? There is no doubt but that improved study methods will stimulate a greater interest in learning and an ambition for higher achievement.

Interest is based upon apperception. Most college students lack imagination to develop interest in abstract matters, but will work hard to acquire knowledge if they see its application. Interest on the part of our students is essential if they are to derive the greatest benefit from their studies. The master teacher should be somewhat of a salesman who can develop in his students an interest in the subjects offered and a desire to learn.

Undergraduate and graduate students who are preparing for engineering teaching as a career should be encouraged to take courses in Education in order to become familiar with the technique of teaching. It may also be well for engineering colleges to offer courses in the "Technique of Engineering Education" in order to improve the teaching powers of their younger teachers. These courses should be given by the most experienced and best known engineering teachers and should bring together in a systematic way the methods found effective in developing the individual student.

Suggestions have been made that engineering teaching would be improved if teachers would spend one year in an industrial organization for every three or five years they spend in teaching in order to acquaint themselves with the actual conditions which will be required of the men they are training. This method would certainly be advantageous for teachers of certain specialized subjects if a practical plan of interchange could be worked out between colleges and industrial organizations, so that the teacher could make the change without too great financial sacrifice. The industries can aid in improving the quality of engineering instruction by providing opportunities for summer employment to engineering teachers and at salaries which will not unduly hamper the teacher whose home expenses continue during the summer months.

In considering the "Technique of Engineering Educa-

tion," it may be well to review some of the suggestions which have been made before this Society in the past with reference to the concentric method of education, steps in engineering education, instruction along functional lines, commercial training, and the teaching of human relations in engineering colleges.

The Concentric Method.—At the Detroit Meeting of this Society in 1908 Professor V. Karapetoff in a paper "On the Concentric Method of Education in Engineering" advocated that engineers should be educated from "practice to theory." In accordance with this system engineering instruction begins with the descriptive side and gradually leads into the theory. Each year is self-contained. In the first year the student is introduced to the whole scope of the engineering profession in a very popular and concrete manner. This gives him time to make his choice among several possible professions, or at least among the different branches of engineering. The second year he studies subjects from a more special point of view and as he progresses there is a gradual change from description and practical instruction into theory and analysis.

In our engineering curricula the major portion of time during the first three years is devoted to abstract but basic subjects, leaving the applications to the last part of the course. In accordance with the "Concentric Method," this would be reversed and the student would be given during the first and second years practical courses closely related to engineering. Such applied courses if taught by men of experience should do much in interesting the engineering student in his studies. The "Engineering Problem" courses which are being given to freshman engineering students in several of our colleges are already making practical the ideal of Professor Karapetoff. The extension of this "Concentric Method" merits careful consideration.

Steps in Engineering Education.—Steps have been advocated in engineering education to meet the needs of industry for technical talent of different quality. This would involve an adjustment of the extent of engineering education to the

capacities of the students and to the requirements of industry. There are some who are of the opinion that men should not be educated beyound the jobs they are likely to hold, and that engineering standards are lowered more by having within the profession many discontented men than by instituting short and highly specialized courses.

To incorporate steps in engineering education would require modifications in the engineering curricula similar to those suggested in connection with the concentric plan of Professor Karapetoff. While more attention should be given to the problem of adjusting engineering training to the needs of industry and to the aptitudes of the individual student, it is doubtful whether it would be practical to provide definite stopping places by making each year in the college curriculum self contained. Intensive and highly specialized courses should be developed in connection with institutions other than engineering colleges. There seems to be some justice in the demand for a kind of technical instruction above that of the trade school, but less scientific and mathematical than that of the engineering college.

Engineering Instruction Along Functional Lines.—Two years ago Professor Edward Bennett discussed the advantages of engineering courses arranged for the functional divisions of industry, such as, research, design, production, application, service, sales, etc., as compared with the present divisions which parallel the lines of demarcation of national societies, such as civil, electrical, mechanical, chemical, and mining engineering. Since industry is largely organized on the functional basis, and the aptitudes of students naturally fall along such functional divisions it would be well for engineering educators to give more careful consideration to the plan proposed by Professor Bennett. While it may be undesirable to discontinue the curricula in civil, electrical, mechanical, chemical, and mining engineering, it may be of advantage, particularly for the larger schools, to arrange options in connection with present curricula which would lend themselves

to the training of students on the basis of their aptitudes along the lines of design, research, production, service and sales.

Commercial Training.—Considerable pressure has been brought to bear upon engineering colleges to train men in the elements of business procedure. The wisdom of trying to train a student in four years for a business career as well as for the engineering profession is very questionable. The engineer must have business sense in order that he may be able to utilize his knowledge to the fullest extent, but this can be developed to a large extent in connection with the various engineering subjects of the curriculum. It is also most desirable to give greater attention to economic and historical studies which will enable the engineering student to understand industrial problems and the science of government which controls his affairs. But, any attempt to teach both commerce and engineering in four years will result only in a superficial knowledge of both.

Appreciation of Human Relations in Industry.—Robert Stephenson as early as 1830 stated that "the most difficult branch of engineering and at the same time the most important is the engineering of men." Industrial advance is dependent upon a thorough understanding of the human factor. The engineer realizes early in his career that human nature is most complex, and that his success is dependent to a large degree upon his ability to impress and influence the men with whom he comes in contact. He must have knowledge of the human element if he is to utilize properly the works he designs or builds. He must realize that the limits of the accomplishments of the machines he devises are set by the men who operate them. Modern industry is daily becoming more involved and calls for leaders of high order who can conceive, create, organize, operate, and direct industrial organizations.

Are our curricula, as at present constituted, deficient in material which acquaint the student with human relations? Should he be taught more about working conditions in industry, tendencies in industrial organization and legislation, and other matters which will enable him better to appreciate

the human problems he will encounter? While the ability to deal with human affairs must largely be learned in industry and not by formal courses, the student should be given every possible assistance in developing the habit of working with others for a common end, the power of initiative, the love of fair play, and the spirit of service.

President Kingsley of the New York Life Insurance Company is of the opinion that colleges should "teach respect for that great charter of human freedom which we call the Bill of Rights. Teach justice and fair play as the fundamentals of good business and, above all, make the students understand that theirs is the task of the master workman; that in their hands lie the forces that can and should and shall, unless they fail, control the world; that theirs is a task more delicate than that of the man who carved the Milesian Venus, more majestic than that of the men who built the Coliseum, *calling for ability to dream dreams and see visions and the power to crystallize those dreams and visions into great business enterprises, even as the people of a few centuries ago crystallized their dreams and aspirations in the cathedrals of Europe.*

"*Therefore educate your students in business management and in other activities, too. Teach them the humanities.* Teach them that they are to guide the forces that have already changed the structure of organized society and the very face of the old earth itself."

Character Building.—The engineering colleges have always instilled into their students worthy ideals of character and conduct. Our engineering undergraduates have moral worth and are serious in their intentions to prepare themselves for right living as well as for useful service. In spite of prejudiced statements to the contrary the American college student as a rule is a very upright and sensible person and particularly so when we consider the examples set before him by some of his elders. But, our engineering colleges must not relax attention to character building, as the stability of society and the basis for authority in democratic government depend upon the qualities of the people. The student must be im-

pressed with the fact that his advancement in his profession, his standing in his community, and his satisfaction with life will depend not only upon his technical knowledge, but also upon his character. He must realize that he is living in an age when truth is considered the greatest social virtue and business is based upon confidence. His success when dealing with men will be measured by his human sympathies, by his nobility of character and by the breath of his vision in his efforts to overcome envy, greed, prejudice, hatred, and indifference.

Mr. Ramsey MacDonald, recently prime minister of England, states that the "Educated man is a man with certain subtle spiritual qualities which make him calm in adversity, happy when alone, just in his dealings, rational and sane in the fullest meaning of the word in all the affairs of his life." These specifications for an educated man should be given esspecial consideration in engineering education.

Since character is largely taught by example it is essential that engineering teachers should possess the highest qualities of character and should have the talent to inspire in their students the desire for better ways of life and nobler character traits.

Development of Personality.—Society expects our colleges to develop thinking men who possess not only outstanding qualities of character but also superior personal traits. Educational institutions in nearly all cases rate students only on academic performance and the grades given are only a measure of brains and application. This system of rating is not a check of the student's personal, moral, or social traits and does not fully show the effect of college residence upon the development of a student. Education should involve selection as well as training. Every student should be encouraged to find out for himself what he is best fitted to do and he should be assisted to develop such personal traits as: Good address, agreeable manner, cheerful attitude, coöperative ability, pleasing disposition, untiring industry, sane judgment, well-balanced initiative, and creative leadership.

Personnel ratings when added to the academic ratings are

of value in promoting self-analysis on the part of a student and are of assistance in discovering his talents. Carefully kept personnel records are also very useful in properly recommending students to prospective employers.

Guiding Students to Discover their Aptitudes.—Are educational institutions fully discharging their duties toward their students when they limit their efforts to imparting information and dismiss those who cannot keep step? Should not every student be a matter of special study and should he not be guided in forming correct notions of his aptitudes? Are teachers doing their full duty when they limit their tasks to the selection of text books, the assignment of lessons, the examination of students, and the recording of student performance? The master teacher bases his teaching upon the aptitudes of the individual, while constantly encouraging the student to discover his own talents and how to use them. Each of our teachers must be given sufficient time to become well acquainted with the characteristics of each student in his classes. He will then be in a position to build every course of study upon the ability, aptitude, knowledge, and experience of his students.

At the Boulder Meeting of the S. P. E. E. in June, 1924, Dean C. E. Seashore in a paper on the "Recognition of the Individual" emphasized the necessity to "keep each student busy at his highest natural level of achievement in order that he may be successful, happy and good." Dean Seashore's views are in accord with the best principles of management. It is undersirable to disregard the personal traits, limitations, aspirations, abilities, and talents of the individual student and to strive for uniformity of output. Instruction should be gaged to the reach of each student with due regard to human differences. The exceptional student should not be worked below his capacity while the slow student should be afforded intellectual opportunities adjusted to his ability. Greater attention should also be given to the right treatment of the talented student who has inventive ability, strong individual emotions, and who cannot be fitted into the stand-

ardized courses of study. Sectioning classes on the basis of ability as determined by entrance and placement examinations should prove of value in giving each student educational opportunities to suit his qualifications.

Cultural Training.—Are our engineering colleges giving sufficient attention to the development of the æsthetic tastes of our students? Have our graduates sufficient appreciation of good books, art, and music? Do they know how to utilize their leisure hours profitably? Do they find amusements in things worth while or do they have to be constantly amused?

Comparisons have been made between the "old liberal arts type" of education which is supposed to develop the æsthetic tastes and that which is offered in engineering colleges. In general, there is no one road to knowledge. Whether liberal arts or engineering education will promote the greatest intellectual growth depends mainly upon the student and his teacher. In a recent address on the "Content of a Liberal Education" Dean Dexter S. Kimball of Cornell University brought out the following:

"In these days of specialization every man must work in a somewhat limited field. In general, the development so obtained does not give him skill or knowledge of other fields. But the affairs of men are many and varied and no man can be said to have a liberal view of humanity who does not know what its vital interests are. If, therefore, he is to be liberally educated he must keep himself informed as far as possible regarding all important social, political, and industrial movements. What, therefore, is vocational to one man is liberalizing to another. Latin and Greek may be strictly utilitarian to the archæologist, while liberalizing to the scientist. A knowledge of some industrial pursuit may be vocational to the man who is making a living thereby, while a knowledge of the same art may be very liberalizing to a divinity student. . . . No man can lay claim to a liberal training if his education has narrowed his vision so that he sees only the good in his own particular field. . . . The great majority of college students, men and women, in all courses, are necessarily undeveloped

mentally; and whether they eventually become liberally educated men and women depends on many things beside the particular studies they pursue in college."

Maintaining Proper Balance with Reference to Student Activities.—The most critical time in the career of college students is during their first year in college. Teachers of freshman students should be selected for their teaching ability as well as for their power to interest and to inspire students. The immature student should be guided so that he does not lose his sense of proportion between studies and student activities. There is danger that the college student will spend too much time at the side shows and miss the show in the main tent. At the same time, however, it may be well to consider the value of these extra-curriculum activities in training students for leadership.

Care must be taken that our students are not misguided by false propaganda to the effect that there is no relation between academic performance or grades and success in life. Statistical studies show very definitely that the superior student has many times more chances to distinguish himself in engineering or in any profession as compared with the student of mediocre record. Cases are found now and then when a student who had high grades in school is a failure. Such cases, however, are rare and can usually be attributed to the fact that the person in question either was unfortunate in attempting a career for which there was no aptitude, had a poor personality, undesirable traits of character, or was one of those people who worked only for grades.

Training for Citizenship.—Greater attention should be given to training for responsible and effective citizenship. The world needs engineers who are obedient to law, who are interested in the common good, who are tolerant of the lawful rights of others, and who do not allow sentiment and prejudice to color their views. To be of greatest service to society men must realize the interdependence of human and property rights, the evils of mob control, and the dangers lurking in aroused class consciousness.

Research as an Aid to Engineering Education.—Progress depends upon men with initiative. Industry rewards initiative and places a premium on men who have the power to take the lead, to plan, to originate. Initiative can best be developed when engineering students are brought into contact with teachers and investigators who are interested in taking new paths, in trying new experiments, and in adding to knowledge. Dr. Arthur D. Little in a recent address discussed the "Fifth Estate" which is composed of "those having the simplicity to wonder, the ability to question, the power to generalize, the capacity to apply, and who bring the power and fruits of knowledge to the multitude who are content to go through life without thinking and without questioning."

Industry needs engineers who have intellectual curiosity and who can qualify for membership in this "Fifth Estate," pioneers who will extend the frontiers of engineering knowledge and who will develop new processes for the conservation and utilization of our resources. Our social and economic system rests upon an industrial basis and the future of industry is dependent upon an accurate comprehension of industrial processes and upon new engineering knowledge. In the earlier days of development in industry much dependence could be placed upon the individual inventor, but with the increased size and complexity of modern industry it is not practical to wait upon chance discoveries, and reliance must be placed upon systematic research to develop new products and to lower production costs. Industrial nations depend in a large measure upon research workers to compete successfully for the commerce of the world.

Closely related to undergraduate and graduate instruction is the pursuit of engineering research which forms the foundation story of the engineering college structure. Such research work besides being of value to industry has a stimulating effect upon students and is most useful in keeping engineering teachers in close touch with engineering pratice and progress.

All or most engineering colleges have never been satisfied

to have teaching or conservation of knowledge as their only function. They realized that efficient engineering instruction must find expression in extending the boundaries of engineering knowledge through research.

At present the organization of about thirty engineering colleges includes research departments or engineering experiment stations. These engineering research departments employ over one hundred full time men and several hundred part time men who are devoting their energies to experimental activities of value alike to the industries, utilities, and people of this nation and of the world. These engineering experiment stations are spending annually about two thirds of a million dollars for research and have published up to date about 500 bulletins which make the results of the investigations freely available to the public. The two oldest of these engineering experiment stations are only twenty years old and the majority have been founded since 1917. However, their contributions to engineering knowledge have been most gratifying. The service of these engineering experiment stations is such as to bring to new economic usefulness cheap structural materials, to develop and conserve natural resources, to advance undeveloped industries, to supply new knowledge in connection with the generation and distribution of power, and to give assistance in connection with the national road-building program.

The industries can assist engineering education and will benefit themselves, though indirectly perhaps, by giving greater encouragement and more liberal support to research at engineering colleges, where fundamental investigations can best be carried on and where adequate attention can be given to the training of research workers. In the present state of world's development there is nothing which will do more to advance engineering education, and so industry, than research conducted on scientific principles. The engineering colleges are the sole source from which the industries can secure trained research men, but the training of such men can not be incidental and can only be accomplished if the engineer-

ing colleges have sufficient funds available to employ research professors and assistants to give careful attention for long periods to the solution of new problems and to the training of advanced students.

Graduate Study.—Should not the superior engineering students be encouraged to better prepare themselves for their life work by graduate study? Graduate instruction has a place in engineering education and is a preparation for the higher phases of the engineering profession. It is particularly useful in connection with the training of engineers who will make research, designing, or education their life work. In exploring new fields, in developing new methods, and in designing new machines the engineer must be directed by a thorough knowledge of things as they are. More of our engineering colleges should develop graduate instruction in connection with their engineering experiment stations to give the exceptional student a broader view, a more thorough scientific knowledge, and a deeper insight.

Graduate instruction in engineering has received a new impetus in connection with the development of engineering experiment stations in colleges, but the number of students who will take advantage of post-graduate training will remain small until the industries and utilities come to appreciate the value of more thorough engineering education than is provided in the undergraduate engineering curricula.

General Public Service.—The main functions of an engineering college include teaching and research. The engineering college can perform additional public service, however, by aiding those men in business and industry who need technical knowledge, but who because of lack of preparation, of time, or of means have been unable to obtain a regular college training. Several of the state-supported engineering colleges have been performing this type of service under the term of "Engineering Extension." Lectures, conferences, extension classes, exhibits, short term courses, correspondence instruction, and publications are being utilized for the purpose of thus disseminating engineering knowledge. The type of extension

instruction given by the engineering college depends upon its location, its resources, and the needs of its community. In undertaking extension activities care must be taken not to duplicate the activities of other agencies. One of the best types of extension work for an engineering college is in the form of two to five day conferences for road builders, power plant operators, electricians, city planners, factory executives, building contractors, electric and gas metermen, and similar groups of mature men who are actually engaged in work related to engineering.

Non-Collegiate Technical Instruction.—Engineering educators should also take a leading part in encouraging the development of a type of technical training to take the place of the apprenticeships. This can be accomplished partly through conferences and short term courses conducted by engineering extension departments of colleges, but mainly by encouraging the establishment of trade schools and continuation schools in industrial centers.

In the industrial centers are found large numbers of workers between the ages of 14 and 18. The proper preparation of these young people for useful service to industry and for good citizenship is of great importance to the public. Modern industry has been compared to a building of several stories with no inside or outside elevators or stairs. The unskilled workers find employment on the lowest story, the next two stories are occupied by semi-skilled and skilled workers, while the executives occupy the top story of the industrial structure. A comprehensive system of technical education should prepare the worker so that he can enter from the outside any of the stories of the industrial structure; it should also provide part-time courses, short term courses, continuation schools and extension instruction for the worker now in the building so that he can climb from one story to another as rapidly as his natural ability and ambition will permit.

It is usually undesirable for the engineering college to undertake non-collegiate instruction, but it should coöperate

with other agencies in developing all types of technical instruction.

Investigation of Engineering Education.—The Society for the Promotion of Engineering Education under a grant by the Carnegie Foundation has been coöperating with about 120 engineering colleges in a study of engineering education. The purpose of this is to formulate the objects of engineering education and determine the fitness of present day curricula. It is hoped that the results of this investigation when placed in the hands of engineering colleges will serve as a guide to intelligent improvement to meet the new demands of the times. As Mr. W. E. Wickenden, who is directing this study on behalf of the Society, has many times pointed out, this investigation differs from the usual procedure in that it originated within the colleges and "the undertaking is a sympathetic study of engineering education by its friends and not a hostile inspection of engineering colleges by their critics." The object of course is entirely a constructive one but the ultimate use which will be made of the results of this investigation will rest entirely with the individual colleges themselves.

So far this study has been concerned mainly with the gathering of facts bearing upon the engineering students and graduates, teaching personnel, services performed by engineering colleges, and special projects pertaining to the technique of education. The U. S. Bureau of Education has been analyzing curricula of engineering colleges, the National Industrial Conference Board has been studying the demand for engineering college graduates in different industries, and other coöperating agencies have been gathering similar facts bearing upon the situation. Analytical comparisons are also being made of the organization of engineering education in Europe and in America.

That this program of fact collecting has most successful is largely owing to the loyalty and coöperation of the engineering colleges who have devoted much time and expense to this investigation. The data which are now being gathered by the coöperating colleges are being interpreted by special

committees of the Society as well as by the staff of the Director of Investigations.

It is hoped that the results of this investigation will be helpful in shaping the future course of engineering education and will prepare the way for an intelligent readjustment of educational programs so that the graduates of engineering colleges will be men of broad vision with the ability to solve the technical problems of their specialty and who can also direct for the benefit of humanity the new forces which science and engineering have created. The engineering colleges have a great opportunity to contribute to the common good by training engineers of character, intelligence and vision, by adding new knowledge through research, and by carrying their influence through engineering extension outside of campus boundaries. The investigation now in progress should prove a new stimulus in connection with these activities and should open for the engineering colleges new fields of service to the public.

Engineering Education and Social Readjustments.—Dr. Arthur D. Little states that:

"Oswald Spengler, in a recent monumental work, forecasts the downfall of Western civilization and would prove his thesis by the history of past cultures. But never in the past has man lived in so compact a world, never has he had such facilities for intercommunication with his fellows, never has he been endowed with such control of natural forces. He has never known himself so well and, above all, never before has he had in his power to direct so definitely the course of his own development. . . . With the reaction of freed intelligence on politics, religion, morals, we might hope for a broader tolerance, a better mutual understanding. With the recognition of the spirituality of science and the divinity of research and discovery should come larger interests and a new breadth of vision to the average man, and to us all acknowledgment of the steadfast purposive striving shown in the development of the creative world, and a reverent appreciation of man's privilege to aid and further this development."

The engineering colleges have a great responsibility to train men who will not only be capable as engineers but who will be able to take an active and leading part in coping with the social readjustments which are becoming at once increasingly necessary and difficult.

The constantly increasing use of power, the tremendous industrial developments, and the miraculous achievements of science and of engineering in annihilating time and distance increase the responsibility of engineering colleges to develop men who have a broad outlook, an appreciation of the sanctity of humanity, and an interest in the common good. The engineer of the future must be familiar, not only with machines, materials and methods, but also with the trend of human progress, so that with the tools of scientific and engineering knowledge he may be able to build a rational world. The wisdom must be his to utilize science for the insurance of the permanency of our civilization.

The opportunity for service by the engineering colleges lies in their vision to adapt their curricula to the changing needs of the times, and in their efforts to train engineers who have the courage to do right, the ability to think straight, the willingness to work hard, the nobility to appreciate the human relations in industry, the personality to make them acceptable to their fellow men, and the breadth of vision to utilize the new forces which science and engineering are constantly creating for the benefit of humanity.

REPORT OF THE BOARD OF INVESTIGATION AND COÖRDINATION.

CHAS. F. SCOTT,

Chairman.

JUNE 18, 1925.

The activities of the Board of Investigation and Coördination during the past year are presented to the Society in the reports of the Secretary, the Director, the Associate Director, the four coöperating committees of the Society and in other papers and summaries to be presented to the convention today.

This general report summarizes the past, presents the present and prospects the future.

1. THE PAST.

"What can the Society do in a comprehensive way to develop, broaden and enrich Engineering Education?"

The Development Committee appointed at the Urbana Convention three years ago made answer to this question by proposing a study of engineering education under the direction of a Board of Investigation and Coördination established for that purpose and authorized to secure funds and organize a staff. The report of the committee was sent in October to deans or presidents of engineering schools who replied giving general endorsement to the plans. A conference then held with Dr. Pritchett of the Carnegie Corporation resulted in a plan presented at the Ithaca Convention two years ago. The Council and the Society in convention assembled, gave approval and pledged support.

The outstanding feature of the plan was a voluntary superstudy of their problems by the schools themselves, properly directed and coördinated; not an external critical investigation. Action was then taken by the Carnegie Corporation and on October 31, 1923, announcement was received of its grant

to the Society of $108,000 during a period of three years for financing the plan. The complete amount was conditional on substantial progress in the first year and a quarter; the condition was removed.

Mr. W. E. Wickenden (former engineering teacher, later acting Vice-President American Telephone and Telegraph Company engaged in investigating and coördinating the educational activities of the Bell System) was appointed Director taking up his duties about eighteen months ago. During the past year Professor H. P. Hammond (for several years chairman of an active faculty committee on Educational Policy in the Brooklyn Polytechnic Institute) has been Associate Director. Their report to the close of 1924, printed in the JOURNAL OF ENGINEERING EDUCATION for February, records the early stages of the undertaking. First was reconnaisance, an effort to define the problem, to clarify the issues, to evaluate the agencies which might take part; visitation to many schools, conferences with many engineering groups, a general survey of professional education. Coöperative agencies were enlisted, among them committees in the faculties of over one hundred engineering colleges, four special committees of the Society, a joint conference group from the National Engineering Societies, a score of National Engineering Societies in specialized fields, the United States Bureau of Education, and there was close coöperation with the extensive survey of the relation of engineering education to the industries being carried on by the National Industrial Conference Board.

After a year's reconnaisance a restatement of objectives and an outline of procedure of the investigation was prepared by the Director and Associate Director in conjunction with a Committee of the Board. This was sanctioned by the Board on the 6th of last December and published in the January issue of the JOURNAL OF ENGINEERING EDUCATION. In accordance with this outline the activities of the past year have been conducted. Various studies have been in progress relating to engineering colleges—their students and graduates, their teachers, their costs, their curricula, their history—to the oc-

cupational demand for graduates, to the relations with professional organizations of engineers, projects in educational psychology and the studies of engineering education in Europe, included in the original plan. In connection with the latter the Director has been abroad for six months. He is here now, but will return to Europe in ten days to complete the work.

Committees and College officials have sent to headquarters quantities of figures regarding personal facts concerning freshmen, the problems of admission, the facts of elimination and data regarding graduates and teaching personnel and other matters. Information concerning nearly 150,000 individuals and aggregating approximately a half million items contribute to the tabulated results which are now available.

2. The Present.

Many results of a fact-finding period now well under way and in some particulars nearly completed are now presented. Here are the facts, a presentation of statistical and factual information never before available. Sometimes it confirms opinions or estimates; sometimes it reveals facts, surprising and even startling. Their significance cannot be appreciated at a glance. Real understanding and appreciation call for painstaking study. This meeting to-day gives a sort of moving picture presentation; reports passed by in ten or fifteen minutes might profitably receive a day's discussion and more. Data concerning many of the fundamental problems of engineering education are now before us.

3. The Future.

What shall we do with our facts and data? What is the next step to be taken? Are they to be filed away? Is our Staff to compile a formal report with a chapter of counsel and advice to be placed on the shelves of the college library? Or can something else be done? Remember, this undertaking is one in which the schools are active, not passive. Remember a plan endorsed by the Society of active participation by the schools was the proposal considered by the Carnegie trustees

when they selected our project from among many others, in sympathy with the practical policy of the canny donor who was ready to help those who help themselves. When the project of the Engineering Societies building was under preliminary discussion the turning point came with his remark—"Oh, well, if you can provide the ground I'll put up the building." And in the present project the engineering schools are participating. The contributions by the schools of funds and time and service as measured in dollars far exceeds the amount received from the Carnegie grant.

A splendid work of the past year has been primarily a compilation of facts and of figures, in the fact-finding, statistical period. Now comes the great opportunity. Here are facts regarding engineering schools in general and regarding particular schools. What do they mean? What do they reveal as to engineering education in general, as to its purposes, its ideals, its methods, its accomplishment, its results as measured in the lives of its graduates? Are its problems being analysed, are its methods being planned, its operations observed, its results studied in a way to insure the effectiveness and the efficiency with which engineers handle other projects?

Most of us think of engineering education in terms of our own experience. Graduates are apt to think that the school of to-day is just what is was in their own day; and college teachers are apt to think that conditions everywhere are just about the same as they are at home. But Messrs. Wickenden and Hammond who have visited many colleges say that they are not the same. The reports give us a knowledge of general conditions.

How does your school compare with others? What in the light of these facts are its excellencies, its deficiencies? What are its particular problems, its opportunities, its difficulties? What is the significance of these facts to the individual school? That is the problem for the individual faculty, the individual dean, the individual teacher. What do these things mean to you? We are not greatly impressed with what others tell us we should do but we are really convinced and urged to action

when we ourselves have made a problem our own, when we have realized its importance and found its solution and realized the steps we should take.

The burden of engineering teaching will soon be passed on to our younger teachers. Their vision of the purpose and the field of engineering education, their ideal of what the engineer should be in his profession and in society will be a large factor in making the future engineering school and its engineering graduate what they should be. A fruitful outcome of the present project is the new vision, the new devotion, the new consecration it may bring to our younger teachers.

Should not committees, which have been active in the first stages, continue action, directing their efforts and that of their colleagues to a study and discussion of the significance of the data we have? This study may be assisted and coördinated at headquarters or by general committees. There may be an interchange of views in some comprehensive plan of discussion.

Some of the subjects now presented may seem minor, but all are essential parts of the large problem. We seek to find the changes in Engineering Education which the conditions of the future will demand. The engineer has been furnishing the fundamentals of a new type of life; his activities have broadened, his responsibilities enlarged; what part is he to take in developing, controlling, safeguarding the new civilization in whose making he has been so large a factor?

REMARKS OF THE ASSOCIATE DIRECTOR OF INVESTIGATION BEFORE THE CONVENTION OF THE SOCIETY AT UNION COLLEGE SCHENECTADY, N. Y., JUNE 18, 1925, H. P. HAMMOND.

Mr. Chairman, Members and Guests:

These remarks are intended essentially as a preface to the reports which will be presented by Committees of the Society which have sponsored the various divisions of the investigation undertaken in the colleges during the past academic year. The substance of the work is contained in those reports. It may be proper, however, by way of orientation briefly to review the purposes of the studies, to give their present status and to mention some of the results of the program as a whole, as an introduction to the reports on its individual parts.

The purposes which the investigation seeks to accomplish are given in a formal statement of the Board of Investigation entitled "A Statement of Objectives and Outline of Procedure," which was issued last December. Copies of this document are available for those who may not have received it. The major purposes of the investigation are given under these headings:

1. It is the intention to clarify the educational functions and responsibilities of the colleges of engineering.

2. It is the intention to establish guiding principles for the content and arrangement of curricula and the improvement of teaching.

3. It is the intention to consider in what ways problems relating to engineering students, graduates and teachers may be dealt with more effectively.

4. It is the intention to examine the practicability and possible benefits of closer group relationships among the colleges and with the professional organizations of engineers.

5. It is the intention to make an analytical comparison of

the organization and practices of engineering education in Europe and America.

It may be seen that the first three of these general objectives relate especially to the engineering colleges themselves.

As to principles and policies to be pursued in carrying on the work, the document states that it is the purpose to devote the period of the Carnegie Grant primarily to the investigative stages of the undertaking and that it is the policy first to gather the facts bearing upon the situation. It has also been a cardinal principle in the investigation from the start that it shall be of a strictly coöperative nature, carried out by and in the colleges themselves, rather than by an outside agency.

These objectives, principles and policies have formed the basis of the program of the year's work in the colleges.

A study of the objectives of the undertaking discloses that data relating to all of the major elements of engineering education have a bearing upon them. The problem then was to select those elements which are susceptible of investigation through a fact-gathering process and to devise a practicable plan for collecting the data with the assistance of a very large number of coöperative agencies with which contact would be maintained primarily only through correspondence. The elements to be studied seemed to be the following: engineering students, their antecedents, characteristics and preparation; admissions procedures; teachers and methods of teaching; engineering curricula; engineering graduates, their careers, experiences and opinions; and the work of the colleges in lines other than those of regular undergraduate instruction. There was considerable limitation in the selection of a plan through which the data could be collected. The method finally chosen was essentially the circulation of questionnaires so devised as to make the mechanical process of collecting and tabulating the information as simple as possible. The various studies were designed not primarily to throw light on particular problems, but rather to furnish information which would bear upon as many of the objectives of the investigation as possible. The characteristics and abilities of entering students, for example,

have a direct and important bearing upon the determination of the function of engineering colleges, the establishment of principles for content and arrangement of curricula, and upon the solution of problems relating to students, graduates and teaching personnel.

The foregoing will serve briefly to indicate the purposes for which and the manner in which the year's program was developed.

At the beginning of the academic year just ended, an invitation to participate in the undertaking was sent to all of the institutions in the United States and Canada which offer engineering courses leading to degrees. This invitation was formally accepted by 114 colleges, the number including, with a very few exceptions, all institutions which have any considerable number of engineering students. In addition to institutions which accepted this formal invitation, a considerable number of others have supplied information or coöperated in other ways. As soon as notifications of the formation of committees to carry on the work were received, each was asked to select from a group of studies those portions in which they were particularly interested, the thought being that a sufficient number would undertake each study to supply a representative sampling of data. This plan worked out satisfactorily and the different projects were undertaken by a sufficient number of institutions of each type to insure adequately representative results.

By the end of October work was in progress in a majority of the participating colleges. This work has gone forward steadily throughout the year and is now practically finished. The speaker wishes to take this opportunity to express the appreciation of the headquarters office for the spirit and manner in which the work has been done. The program has involved a considerable amount of work which has been in addition to regular teaching and administrative duties. The practically universal response to the Board's invitation and the excellent nature of the work done by committees is concrete evidence of the interest of the colleges in the investigation and of their endorsement of its principles.

The present state of progress on the several projects is indicated in a condensed summary statement which has been prepared and distributed in order to avoid the recitation of statistical information. The statement gives the names and index numbers of the various projects in accordance with the system adopted for purposes of office routine and organization. The amount of work now needed finally to complete each of the projects is given. The statement includes not only those projects relating to the work of the college committee, but other portions of the program which have been in progress during the year.

Most of the data sought have now been obtained, though there are a few committees which have not reported on particular studies. Only one of the four major divisions of the work involving coöperation of faculty committees remains substantially uncompleted. This project, which relates to the service and facilities of the colleges, will be carried forward in the office during the summer and it is hoped to complete it before the opening of college next year. Limitations of size of staff and of time have made it impossible to bring this study to the same stage of completion as the others.

In some of the projects which are substantially complete there are a few details which remain to be finished. Some information has been received since the first tabulations and summaries were prepared. This and other data to be received later will be added to the tabulations and amended summaries will be issued. It is probably an opportune time to ask the assistance of committees in cleaning up whatever remains to be done to complete work undertaken. Since the studies have thus far progressed so satisfactorily and such a large body of fact has been assembled, and since comparatively little needs to be done to round out this year's program completely, it seems worth while to pull the few loose ends together.

The summaries which accompany the committee's reports do not give all of the analyses to which the data will be subjected. Certain others will be carried out in order that the results may be of the greatest possible service and so that the information may be interpreted from a number of points of view.

The reports of committees on studies in which the data are now felt to be virtually complete have been printed. Others which are not so nearly final in nature have been reproduced from typewritten pages at a considerable saving in cost.

As to the manner in which the mechanical handling of the statistical information has worked out, it may be said that the arrangements have been such and committees have submitted reports in such manner, that an office force of four persons, carrying on at the same time many other duties connected with the investigation, including a heavy correspondence and visits to a considerable number of institutions, etc., has been able to handle the compilation and preliminary analysis of slightly less than five hundred thousand separate items of data and that we still live to tell the tale.

The above, in brief, is a hasty survey and summary of the year's activities. It is believed that the program as a whole has worked out satisfactorily and that the results constitute a testimonial to the spirit of the coöperative agencies which have participated.

Since all of the data gathered thus far have passed under the speaker's observation, it may be proper to give a brief summary of some of the outstanding features noted in the preliminary analyses which have been made. These remarks are in the nature of comments and are in no sense conclusions or recommendations.

It is apparent from the most cursory examination of returns that the quality of preparation of entering students is seriously unsatisfactory in the essential elements of training and mental discipline which should precede an engineering education. The evidence submitted is of such a nature and comes from so many sources that it is believed to have resulted only from actual conditions and not from unsupported opinions. The most serious deficiencies appear to be in the knowledge of the fundamental principles of elementary mathematics and in English. Students appear to have little idea of thoroughness and very little self-reliance. One committee puts the matter aptly by stating that students appear to have

been taught to solve easy problems by imitative methods. It must be remembered that this condition holds in spite of the fact that a large proportion of our students come from among the best graduates of the high schools.

The figures on entrance conditions of students admitted in the fall of 1924 are quite significant. One student in eight was admitted with conditions in mathematics and these conditions are by no means limited to those in Solid Geometry. It is becoming increasingly necessary and customary for colleges to segregate to special sections students having defective preparation, thus putting an added burden on the teaching staff, complicating programs quite seriously, and tending to lower the level which has been assumed as that at which college courses in engineering begin. While it is always possible to view a situation in the light of the cases of exceptional students, it is doubtful, in view of the evidence, whether the admission of large numbers of conditioned students by colleges which are not forced by law to admit all graduates of accredited high schools is a wise proceeding. It is possible that the situation as to preparation may in part be due to a lack of contact and coöperation with the secondary schools. Some institutions indicate that steps are being taken in this direction, but they are the exceptions and there seems to be opportunity for much more extensive and effective measures than have been instituted in the past.

An interesting picture of the grounds on which high school boys form their decisions to go to college and to study engineering and upon which they select a particular course of study is furnished by the report of the Committee on Engineering Students and Graduates. This indicates an opportunity for more effective measures to supply high school boys with reliable information on the nature of engineering courses and the engineering profession. The fact that the decisions mentioned are formed at quite an early stage in the high school course is something of a surprise and indicates that the time for such guidance as may be given is not just before graduation from high school but at a much earlier time.

The studies bring out the increasing attention being given by the colleges to the orientation and motivation of students just after admission. The practice of gathering the freshmen together on the campus before the usual time of registration and of endeavoring systematically to give them a proper start in their college course, which was begun two years ago at the University of Maine is being rapidly adopted by institutions throughout the country. Orientation and engineering problem courses for freshmen designed to develop a general knowledge of and interest in engineering are being given in a larger number of institutions every year. In general, more and better attention is being given to guidance of students in their selection of courses and in efforts to start them thinking from the standpoint of the engineer.

Another phase of educational and vocational guidance is brought out in the study of recent graduates. A very considerable proportion of graduates make numerous changes of employment during the first two or three years after leaving college. A large majority of graduates indicate that their reason for choice of first positions is the desire for the right sort of experience and opportunity rather than for immediate return in salary. Yet many appear to find themselves in unsuitable positions. The colleges and the larger industries are now doing considerably more in an effort to place graduates properly than was the case a few years ago, yet it appears that much is yet to be done before this matter is in reasonably satisfactory condition.

One graduate expressed his views on this matter in the following words:

I consider that the field of greatest service of the University is in vocational guidance based upon a thorough and scientific knowledge of vocational psychology. To me, the greatest of all tragedies is "the square peg in the round hole." I know, for I have been one. The greatest work a college of engineering can do, in my estimation, is to study the man, his inclinations and native abilities and then start him right, whether his field of real usefulness is engineering, sales work, or scenario writing. A right start is a fortune in itself.

Returns from both recent and older graduates indicate a very marked and almost universal feeling that engineering courses should give more or better training in the principles of economics and in the knowledge of business procedures. It is difficult to judge how much of this feeling may arise from a belief that training of this nature would lead to larger remuneration and more rapid advancement to positions of responsibility in industry, or, on the other hand, to determine the relationship of the replies to the courses from which the men graduated or the types of positions which they fill. Yet in spite of these reservations the desire for more training of this character in engineering courses is so widely expressed and confirmed in so many ways that it would seem to suggest early and careful attention to this phase of engineering courses.

At the same time it is to be noted that one of the most significant results of the studies is the fact that graduates indicate clearly their belief that the scientific and technological portions of engineering curricula constitute their major elements and that they are the real foundation of the training of an engineer. There are probably few who will disagree with this belief, yet in the past few years so much discussion has centered around portions of curricula other than scientific and technological subjects, and so much has been said regarding a broad general training for engineering students, that it may be well to call attention to this result of the studies which fixes attention on the fact that the fundamentals in the training of an engineer are and always will be science and technology.

A very interesting and significant result of the studies is the difference in the feeling of entering students and of graduates as to the importance which they attach to English and cultural subjects. Many of the freshmen state that they did poorly in these studies in high school and even disliked them. Graduates, on the other hand, place scarcely less emphasis on their value and importance and the need for more or better training in them than they do on the economic and business subjects as

above mentioned. The desire of graduates for a better ability to express themselves seems, indeed, almost pathetic. If there is an increasing appreciation of these subjects as students progress toward graduation, does it not possibly suggest that English and cultural subjects might be distributed more uniformly throughout the four years instead of largely concentrated in the first two? Institutions which have placed cultural subjects in the last two years and have then seen to it that they are given by good teachers report that students exhibit a lively interest in the work and that graduates speak of a continuation of such study from the stimulus which they receive in college.

Another feature of the study of graduates is the fact that a large majority believe that engineering courses should be differentiated in type so as to provide a broad and general training for the majority with specialization for those who have the qualifications or the time needed to pursue such courses or who have as an objective a specific line of work for which they are preparing.

A portion of the investigation which will probably be of considerable interest is the study of the financial status of engineering teachers. It is believed that the data obtained are both accurate and valuable, constituting as they do a successful effort to obtain comprehensive and reliable figures on a particular professional group. The report of the Committee on Teaching Personnel also brings out a number of important aspects of the recruiting and developing of teaching staffs which should be of interest to college executive and administrative officers. The figures on salaries and supplementary earnings which have been tabulated and published are the result of a first analysis of the returns. Further analysis will be made.

To the speaker one of the most interesting and yet disquieting results of the investigation is embodied in the report of the Committee on Admissions and Eliminations. Elimination ratios have been compared with those in a number of other professional courses. It is found that a considerably larger per-

centage of students who enter are eliminated from engineering colleges than from other professional schools. It is also found that scholastic failure accounts for the majority of the eliminations and that financial difficulty, health, and other factors are less important than commonly supposed. The results obtained from the study of former students who left college before graduation confirm the data supplied by the college authorities from office records. Special studies are in progress, and it is hoped that they will be undertaken by a larger number of institutions next year, to get at the fundamental causes of these failures.

The Committee on the Services and Facilities of the Engineering Colleges, through its Secretary, has gathered and will present a very interesting compilation of the costs of engineering education. The total figures reach surprising amounts.

In concluding these remarks the speaker would like to take the opportunity to express appreciation of the cordial reception accorded in institutions visited during the past year. Obvious limitations have permitted fewer of these contacts with committees and faculties than would have been desirable. Such visits as it has been possible to make have not only been profitable to the investigation but they have been exceedingly pleasant and have compensated in large measure for the arduous work of the year.

SUMMARY REPORT OF PROGRESS IN THE FACT-GATHERING STAGE OF THE INVESTIGATION.

JUNE 1, 1925.

DIVISION *A:* Relating to the Past Experiences and Present Practices of the Colleges.

Subdivision a. Projects relating to students, graduates and former students.

*Aa*1. *Study of Entering Students.*—44 coöperative faculty committees signified intention to undertake the project. Data supplied by 32 committees have been summarized, tabulated and studied. A preliminary report of the Committee sponsoring the project has been published.

Additional work in this project will consist of the completion and refinement of the data and their further study.

*Aa*2. *Study of Admissions and Eliminations.*—A study of admission has been made from the catalogues of 122 institutions and from reports furnished by 72 faculty committees. Studies of eliminations have been made based upon data supplied by 38 institutions. A preliminary report by the Committee sponsoring the project has been published.

The statistical data will be given further study and an investigation of the fundamental causes of scholastic failures will be continued during the ensuing academic year.

*Aa*3. *Study of Engineering Students Other than Freshmen.*—This project has been undertaken by three committees along lines determined by the committees themselves. No report has as yet been prepared. The data will be summarized and studied during the ensuing year.

Aa4. Study of Engineering Graduates and Former Students Who Did Not Graduate.—51 institutions indicated that they would undertake all or portions of this project. Reports have been received as follows: Form 4B, Recent Graduates, from 36 committees; 4D, Older Graduates, from 30 committees; 4F, Former Students, 13 committees. Due to the volume of work a number of the larger institutions have not submitted data. Data received to May 15, 1925 have been tabulated and a preliminary report of the Committee sponsoring the project has been published.

Work remaining to be done in this project consists of completing the data, summarizing and analyzing it, and preparing reports based thereon.

Aa5. Study of a Special Group of Graduates in Electrical Engineering.—This special study has been undertaken by a fraternity having a graduate membership of several thousand representing the various types of institutions and parts of the country. The study relates especially to the teaching of economics and to the need of training in economics and business methods by engineering graduates.

The data have not as yet been completely tabulated or summarized. The work will be continued and a report published.

Subdivision b. Projects relating to teachers of engineering.

Ab1. Study of Teaching Personnel.—The studies undertaken relate to the economic status of engineering teachers, the sources from which they are drawn, policies as to training and developing younger teachers and the extent of the drain of the industries upon teaching staffs. Data supplied by teachers in 75 institutions as to salaries and supplementary income have been summarized and published. Information has been obtained from 116 institutions regarding policies as to other matters mentioned above.

This has been summarized and a report prepared by the Committee sponsoring the project.

Work remaining to be done consists of completion of collection of data and compiling and summarizing it. Plans for further studies will be considered in the near future.

Subdivision c. Projects relating to engineering colleges.

*Ac*1. *Study of the Scope and Field of Work of Engineering Colleges.*—Data have been obtained from 98 institutions and are now being summarized and analyzed.

*Ac*2. *Study of Costs of Engineering Education.*—Data supplied by 40 institutions have been summarized by the Committee sponsoring the project and a preliminary report presented. This study will be continued, additional data will be obtained and the figures will be harmonized and refined.

Subdivision d. Projects relating to engineering curricula.

*Ad*1. *Study of Entrance and Graduation Requirements of Engineering Colleges.*—This project is being carried out by the United States Bureau of Education. Summaries of curricula have been prepared from catalogues and sent to the colleges for verification. Reports are being prepared in installments of 25 institutions each. The first installment has been prepared and distributed. Others will follow.

Subdivision e. Projects relating to the history of the colleges of engineering.

*Ae*1. *Study of Educational Requirements and Standards of Other Groups of Professional Schools.*—Data relating to this project have been gathered and compiled. A report on the relationship between Professional Schools has been prepared and published. (See JOURNAL OF ENGINEERING EDUCATION, December, 1924.)

DIVISION *B:* Dealing with the Relationship of Engineering Education to Industry.

Studies of this aspect of engineering education are in progress by the National Industrial Conference Board under the sponsorship of a Joint Advisory Committee composed of representatives of industry and of the colleges of engineering. A preliminary survey from census data and other sources has been published. (See *Proceedings* of the Society, Vol. XXXI, page 136.)

Surveys of industrial group organizations in the paper, rubber, textile, metal and other industries are in progress or completed. Reports on these studies may be obtained from the National Industrial Conference Board, 247 Park Avenue, New York City. These deal with opportunities for engineering graduates in the industries, the positions they hold, how the industries absorb them, and the variety of technical training which will better qualify graduates for responsible positions in industry.

Other studies are under consideration or in progress in the field of public utilities, *e.g.,* electric light and power, transportation, communications, etc.

DIVISION *C:* Relations with Professional Organizations of Engineers.

Subdivision a. Projects relating to professional status in engineering and other professions.

*Ca*1. *Inquiry into the Definition or Characterization of Professional Status and of the Professional Status of the Engineer.*—A formulation of the attributes of individual and group professional life has been prepared. This inquiry will be extended.

*Ca*2. *Inquiry into the Distinctive Characteristics of Engineering as a Profession in Relation to Engineering Education.*—This inquiry has been begun and will be continued.

*Ca*3. *Inquiry into the relations between Professional Schools and Professional Organizations in Medicine, Dentistry, Law and Architecture.*—Data relating to this project have been gathered and compiled. A report has been prepared and published. (See

JOURNAL OF ENGINEERING EDUCATION, December, 1924.)

Subdivision b. Projects undertaken coöperatively with the four Founder Societies and with other engineering societies.

*Cb*1. *Study of the Major Divisions of Engineering Practice in Each of the Principal Engineering Fields.*—Each of the four societies has accepted an invitation to coöperate and has referred a memorandum outline of the study to a committee of its membership.

*Cb*2. *Study of Training for the Specialized Divisions of Engineering Practice.*—A group of engineering societies in the specialized divisions of practice has been invited to contribute to this inquiry. A number of the societies have accepted the invitation and committees have been appointed to carry out the work.

DIVISION *D:* Studies and Projects in Educational Psychology.

*Da*1. *Vocational Differentiation and Guidance of Secondary School Students.*—Data relating to this study have been gathered under project *Aa*1. Further inquiry into this phase of the investigation and study of the problem will be carried out.

*Da*2. *Review of Current Opinion as to the Philosophy of Educational Objectives.*—A preliminary compilation and summary of opinion has been prepared.

*Da*3. *Experiments with Placement Examinations.*—The colleges were invited to give placement examinations in English, mathematics, chemistry and French to Freshmen entering in 1924. Thirteen institutions submitted scores made in the examinations and in corresponding college subjects. These have been submitted to and studied by the staff of the Department of Psychology and Philosophy of the University of Iowa. The results will be available in the near future. The examinations have been revised in the light of experience. An additional aptitude

and training series in physics has been added. These are now available and colleges are invited to cooperate by giving the tests in the fall of 1925.

*Da*4. *Individual Diagnostic Studies of Cases of Impending Student Failures.*—This project was carried out at Purdue University during the academic year 1924–25. A preliminary report on the study will be prepared. The study will be continued and colleges are invited to participate. Plans of procedure will be furnished upon request.

DIVISION *E:* Investigation of Engineering Education in European Countries.

Studies under the following particular projects have been made by the Director in Europe during the first half of 1925. Preliminary reports in the form of "News Letters" have appeared in the JOURNAL OF ENGINEERING EDUCATION. (See issue of the JOURNAL for April, 1925.) Further reports will be presented.

*Ea*1. Inquiry into the plan of organization of higher engineering education in its relation to other forms of higher, intermediate, and secondary education.

*Ea*2. Inquiry into organization and conduct of engineering schools.

*Ea*3. Inquiry into relations of engineering schools to engineering professional organizations.

*Ea*4. Inquiry into relations of engineering schools to the industries.

*Ea*5. Inquiry into the relations of the engineering schools to public administration.

SUMMARY AND REPORT, PROJECT Aa2.

A STUDY OF ADMISSIONS AND ELIMINATIONS OF STUDENTS OF ENGINEERING.

JUNE 1, 1925

Data presented in this report have been obtained in part from reports furnished by committees of the faculties of co-operating institutions and in part from catalogues of Engineering Colleges. The forms used in collecting and tabulating the information are not reproduced, but may be obtained from the office of the Director of Investigation, Society for the Promotion of Engineering Education, 33 West 39th Street, New York City. Information from catalogues has been compiled for 116 institutions in the United States and six in Canada. Seventy-two faculty committees supplied other information. The number of institutions represented in tables relating to eliminations and to the causes thereof is given in each of the tables in which such data are compiled. The statistical information is very much condensed from preliminary tabulations upon which it is based. The complete tabulations may be consulted at the office of the Director of Investigation.

The project was carried out under the sponsorship of the Committee on Admissions and Eliminations:

H. H. Jordan, Chairman,
G. W. Munro, Secretary,
O. J. Ferguson,
L. L. Thurstone,
C. L. White,
W. D. Emerson,
T. P. Harrison.

The report of the committee is given in the following pages. A preliminary discussion, based upon partial returns, appeared in the *Journal of Engineering Education* for March, 1925.

H. P. Hammond,
Associate Director of Investigation.

REPORT OF THE COMMITTEE ON ADMISSIONS AND ELIMINATIONS OF ENGINEERING STUDENTS. MAY 1, 1925.

GENERAL CONSIDERATIONS.

Any discussion of the problems relating to the admission of students to the curricula of engineering colleges and schools, and their subsequent elimination therefrom, would be loose and ineffective unless predicated upon careful consideration of the numerous and diverse elements involved in these two processes. Your committee assumes that in assisting in the accomplishment of this task it may find partial justification for participating in the program of this convention.

In the second place, there has been laid upon the committee the duty of examining the data collected by the Director's Office touching upon these two fundamental problems of engineering education and offering whatever suggestion and comment upon them may seem worth while at this time.

Lastly, we conceive it our function to formulate some specific statement of just what the present major problems of admissions and eliminations really are and to suggest the direction which further study of these questions may take in order to achieve the best results from the investigation now under way.

We call attention at the outset to the very complexity of the problems with which we are dealing. Beyond a mere paper decree as to what the qualifications for admission shall be, the engineering colleges have little direct control over the actual preparation of candidates who apply for admission. The various points of view and standards of instruction prevailing in the public schools of the United States and Canada constitute one of the major elements in the problem. The private and parochial schools introduce a second element of variance and, to some extent, the school systems of foreign countries also have their effect on the situation.

Still more important than these differences which exist in the broad and general sense, are those found to prevail between public schools of the progressive and well-to-do communities and those of the poorer and less progressive places. Fre-

quently these differences in educational efficiency are large even within areas of small geographical extent. Therefore, they affect the admission standards of the local institution vitally and exert a considerable though less direct influence on the distant college to which some of the students may migrate. The problems of admission from this point of view become wholly local in character, as do the problems of elimination. Legislatures and State Boards of Education may, by their acts, accentuate the difficulties encountered in such a situation and frequently they cause embarrassment in maintaining proper college standards.

Economic changes of recent years have greatly increased the educational opportunities of our young men and women. The numbers of students attending our secondary schools have increased correspondingly with attendant ill effects upon the scholastic standards of those schools due to overcrowding and too limited staffs. More of these same poorly prepared graduates of high schools than formerly find it possible to attend college and thus the problem of overcrowding and consequent lack of fundamental preparation has been pushed up into the very gates of our institutions of higher education. For privately endowed colleges and universities the solution of this difficulty may be readily found, but for state supported institutions the way out is not so clear.

Another element which adds much to the complexity of the problem of admissions is that of the new emphasis laid upon vocational and physical culture subjects in the high schools. The result is that the character of the pre-engineering school training has been greatly modified. It appears that candidates who will offer themselves in years to come, will be less, rather than better, prepared to undertake rigorous college mathematical and scientific work.

STATUS OF ADMISSION REQUIREMENTS.

The data collected thus far by the Director's Office and available to your committee for study, disclose the following facts:

1. The ratio of freshmen to the total enrollment, in 60 institutions reporting, for the years 1923–24 and 1924–25 averages 35.8 percent. The ratio of students admitted to advanced standing to the total enrollment for the same two years is 4.9 percent.

2. Among one hundred and eleven institutions well distributed over the United States and Canada, including the University of Hawaii, and fully representing the various types of institutions which offer engineering courses, the paper requirements for admission are very uniform in the number of high school units required and also, to a large extent, in the kind of units required. Ninety-two percent of these institutions require a total of fifteen units. Three institutions require sixteen units while six require fourteen or fourteen and one-half. The nine Independent Polytechnic Institutes reporting show the greatest spread in requirements, their range being from fourteen to sixteen units. Only in the New England and North Middle Atlantic institutions does an admission requirement below fifteen units exist.

3. Practically ninety-four percent of the 116 institutions studied admit students on credentials from accredited high schools. Notable exceptions are the Canadian Universities, the Massachusetts Institute of Technology, Harvard, Princeton, and Yale. Nearly eighty percent hold entrance examinations for those candidates who do not come from accredited high schools. Six institutions have their own entrance examinations in certain subjects. Princeton and Yale admit only on credits of the College Entrance Examination Board.

4. Sixty-five percent of the institutions specify what one-half or more of the entrance credits shall be. The average specification is 8.7 units. The average specification for mathematics is 2.8 units. Sixty percent of the institutions require Solid Geometry. Sixty-one percent specify one or two units of science. Beyond these fixed requirements we may consider the additional credits to be offered as optional over a wide field of selection. Increasingly these options tend to the vocational and physical education subjects.

5. Among 8,728 students admitted to 52 institutions in the

fall of 1924, 1706 or 19.6 percent were classed as "conditioned students," distributed as follows: mathematics, 67.3; science, 21.3; English, 3.8; languages, 12.4. Eleven institutions of the 52 reporting do not allow conditioned students in their engineering departments. The highest percentage reported by any institution is 62.7. Fifteen report percentages higher than 30. Apparently a considerable percentage of the students admitted with conditions in mathematics have their deficiency in Solid Geometry and the third half-unit in Algebra.

Your committee draws attention to several matters gleaned from the data at hand.

a. Except in the matter of elective subjects, the list of entrance credits presented by a graduate of the modern high school is hardly different from that presented by a student twenty-five years ago.

b. Although the catalogue statements of the requirements for admission to engineering schools and colleges are uniform and, we believe, adequately high, the quite general admission of "conditioned students" nullifies the real and potent influence a fixed standard may exert. The inference to be drawn here is that colleges feel compelled by law or by the spirit of fair play with the high schools to admit such students or they must feel that the chances of these students are about equally good with those bringing the full entrance requirements.

c. In nine institutions where figures were available, the percentage of students beginning the sophomore year who were admitted as conditioned and non-conditioned in mathematics were respectively 41.1 and 57.2. In only one of the nine institutions did the conditioned men survive as well as the non-conditioned men.

d. The large number of elective subjects in the high school curriculum is confusing to the average boy. Many subjects of his selection do little to develop intellectual power and fitness for college work. They absorb abnormal amounts of the student's time much to the detriment of his fundamental courses. The defence of this system presumably is

that the high school's business is to prepare for life's work and not for college work.

e. Few schools (13 out of 65 reporting) use the Intelligence Test as a definite part of their admission system.

f. Several schools (15 out of 64 reporting) use the personal interview or "appraisal" method in selecting their entering students.

g. Eleven institutions out of 70 reporting limit their enrollment in engineering courses.

The fundamental problem of admissions to engineering courses does not appear to be one of mere shifting of paper requirements but rather one of better grounding in the high school subjects now specified for entrance. Also, the question of guidance in the selection of electives and in the proper course to pursue in individual cases is one demanding more consideration than has, hitherto, been given it by parents and high schools. The native ability of our youths can hardly be considered less than it was twenty-five, fifty, or one hundred years ago.

Your committee raises the question: How can the engineering colleges exert a direct and effective influence on the preparatory schools in the way of securing greater emphasis and better instruction in the subjects of the high school curriculum which are fundamental to collegiate study? We also raise the question: Is there a need of additional selective methods over and above the present system of admitting on scholastic credits alone?

STATUS OF ELIMINATIONS.

The statistics on eliminations are not complete. Enough are at hand, however, to permit of some definite statements. Among thirty-eight institutions well distributed over the United States and Canada there is a noticeable uniformity in the percentages of elimination over certain geographical sections, but wide variations appear when the institutions are taken as a single group. There is no reason to believe that the figures will change much as other institutions report their

statistics. The method of reporting by five-year periods is fair and conveys a rather accurate picture of the situation. The following digest of the data at hand is presented:

1. The percentage of students admitted to thirty-eight representative institutions during the five-year period of 1899–1900 to 1903–1904 who graduated in the succeeding period of 1902–1903 to 1906–1907 was 43.5. The percentage of eliminations, therefore, was 56.5. The percentages of eliminations for the succeeding five-year periods are 57.2, 58.1, 62.4 and 61.6 for the two-year period represented by the classes of 1923 and 1924. If the demoted and otherwise delayed students are omitted from our calculations and graduations in four years make the base line, these percentages are increased on an average to about 72 percent.

2. The Canadian schools show a lower elimination rate than do the American schools, especially during the war.

3. The New England and Middle Atlantic institutions show a lower rate of elimination than any other geographical group in the United States.

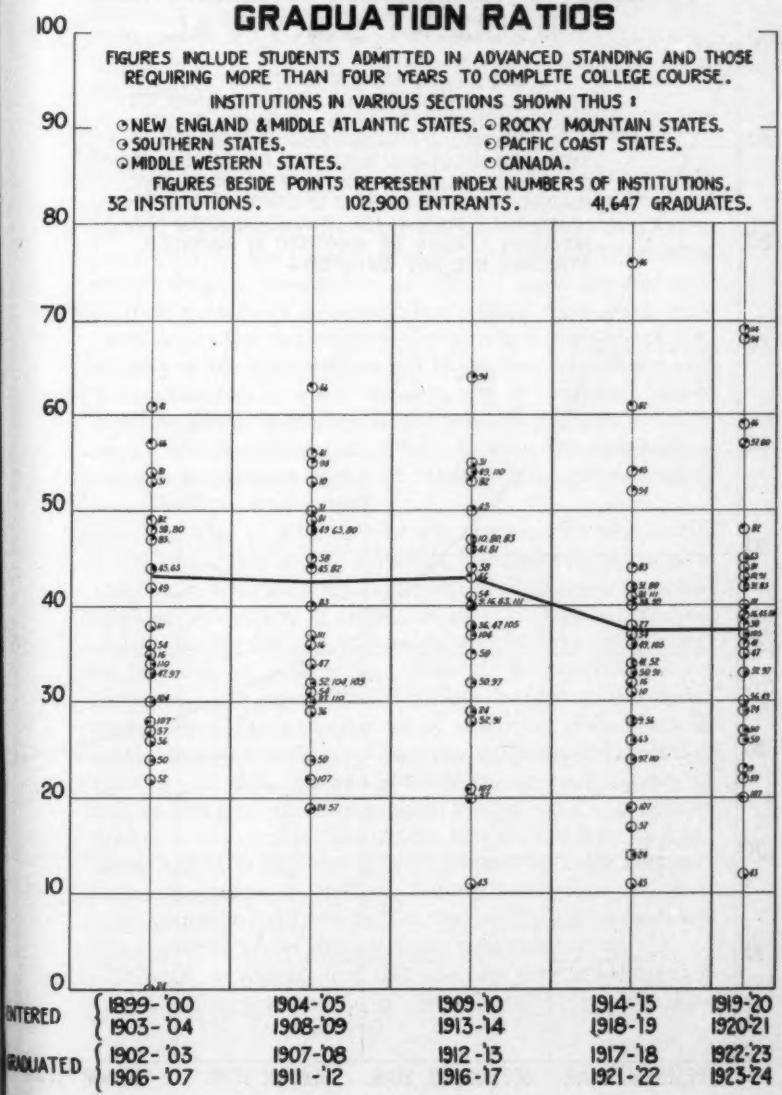
4. The causes of eliminations are various and not well determined. The data collected for the classes of 1923 and 1924 in twenty-three institutions claiming fair knowledge of the causes of their eliminations show the following figures: scholastic failure, 53.8 percent; voluntary change of course, 15.5 percent; financial reasons, 9.1 percent; health of student, 5.5 percent; dismissal for conduct, 2.7 percent; family reasons, 1.5 percent; other reasons, 2.7 percent; and unknown reasons, 9.6 percent. These data are subject to question because of the fact that institutions as a whole have not kept accurate records of these matters, but it is a significant thing that the causes of more than 50 percent of the eliminations in these institutions are ascribed to "scholastic failures." In a group of five other institutions where the "unknown causes" are listed as 41.7 percent, the "scholastic failures" are given as 36.1 per cent.

5. The causes given by the various institutions for the failure of students to do satisfactory work are: poor prepara-

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

STUDY OF ADMISSIONS AND ELIMINATIONS

GRADUATION RATIOS

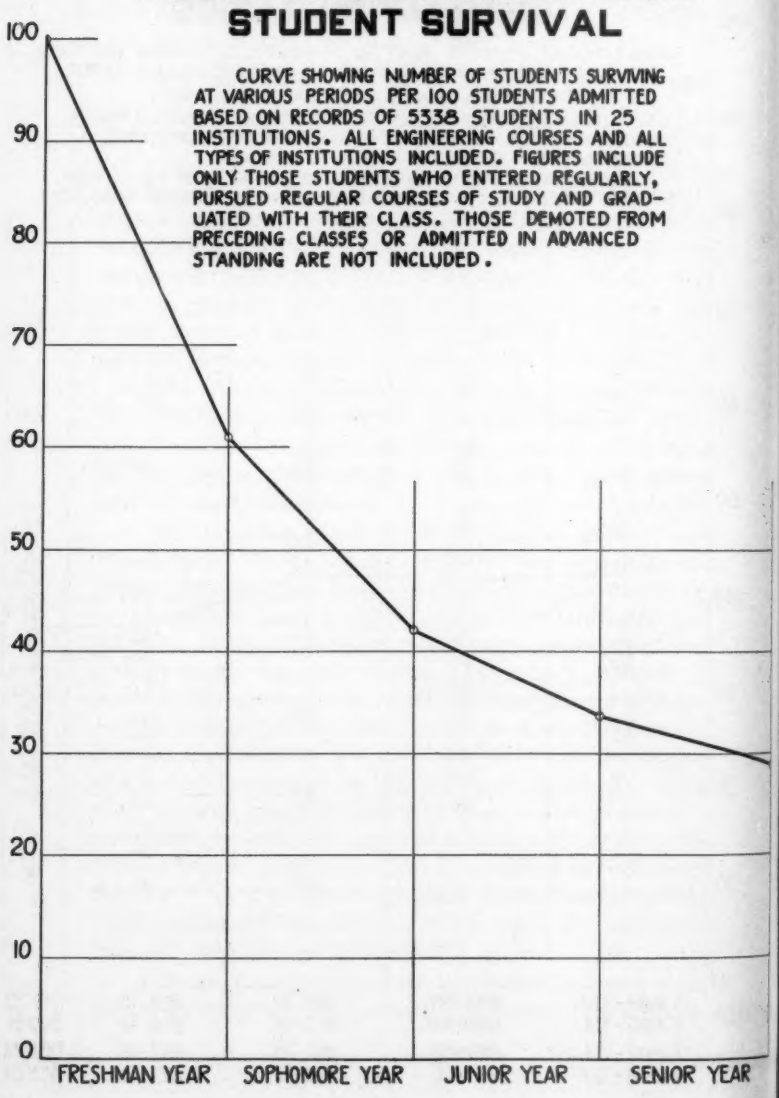


ENTERED	1899-'00	1904-'05	1909-'10	1914-'15	1919-'20
	1903-'04	1908-'09	1913-'14	1918-'19	1920-'21
GRADUATED	1902-'03	1907-'08	1912-'13	1917-'18	1922-'23
	1906-'07	1911-'12	1916-'17	1921-'22	1923-'24

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

STUDY OF ADMISSIONS AND ELIMINATIONS

STUDENT SURVIVAL


CURVE SHOWING NUMBER OF STUDENTS SURVIVING AT VARIOUS PERIODS PER 100 STUDENTS ADMITTED BASED ON RECORDS OF 5338 STUDENTS IN 25 INSTITUTIONS. ALL ENGINEERING COURSES AND ALL TYPES OF INSTITUTIONS INCLUDED. FIGURES INCLUDE ONLY THOSE STUDENTS WHO ENTERED REGULARLY, PURSUED REGULAR COURSES OF STUDY AND GRADUATED WITH THEIR CLASS. THOSE DEMOTED FROM PRECEDING CLASSES OR ADMITTED IN ADVANCED STANDING ARE NOT INCLUDED.
100
90
80
70
60
50
40
30
20
10
0
FRESHMAN YEAR
SOPHOMORE YEAR
JUNIOR YEAR
SENIOR YEAR

tion or lack of ability, 69.4 percent; health, 7.2 percent; self-support, 5.3 percent; fraternity and social, 2.7 percent; entrance conditions, 1.3 percent; undergraduate activities, 1.8 percent; other causes, 2.8 percent; and unknown causes, 9.5 percent.

Upon the matter of eliminations your committee offers the following comment:

a. The elimination rate is high and steadily growing higher. Graduation from engineering colleges in four years is a reality for less than 30 percent of the students entering these colleges. Graduation at all is a possibility for less than 40 percent of those entering. These figures are tempered somewhat in their severity by the knowledge that a number of students transfer out of engineering colleges and later graduate in other departments of learning. Such students should not count in our mortality figures. There are no reliable figures available for Liberal Arts and Science colleges but comparisons with Agricultural colleges appear unfavorable to engineering.

b. The rate of eliminations will continue to increase in direct proportion to the failure of the high schools to give training in essential preparatory work, in proportion to the increase of distracting influences in both high school and college life outside the class room, and in direct proportion to the lack of balance and stimulus in our engineering curricula. We repeat that it cannot be true in the main, that students fail and drop out of college because of lack of inherent natural ability. They may not possess engineering aptitude, but the first two years of college work cannot be said to put any great strain upon the bonds of engineering aptitude. It is unfortunate that the data before us combines lack of ability and lack of interest into one group in listing the causes of scholastic failures.

c. Approximately one-half of the total elimination takes place prior to the beginning of the sophomore year.

It must be remembered that the first year in college is a career finding year and many men discover themselves mis-

placed in an engineering college leading to an engineering vocation and promptly and properly change, so that the fact of a large elimination the first year does not present an alarming aspect of the situation providing the students dropping out get as much out of their one year of experience as they would anywhere else and providing, further, that the money spent in the process can be justified on this ground. Unhappily the records of these men show poor achievements. The majority are listed as scholastic failures. It is proper to inquire in this connection what may be done to bridge the gap between high school and college so that the jar and shock will be less and the achievement greater.

d. Over twenty-five percent of the students beginning their junior year do not graduate with their class. This figure corresponds roughly with the elimination rate of colleges of medicine and law.

e. The methods of handling students attempting to transfer from one institution to another are such that floaters and men of very low records are effectively eliminated from the educational system.

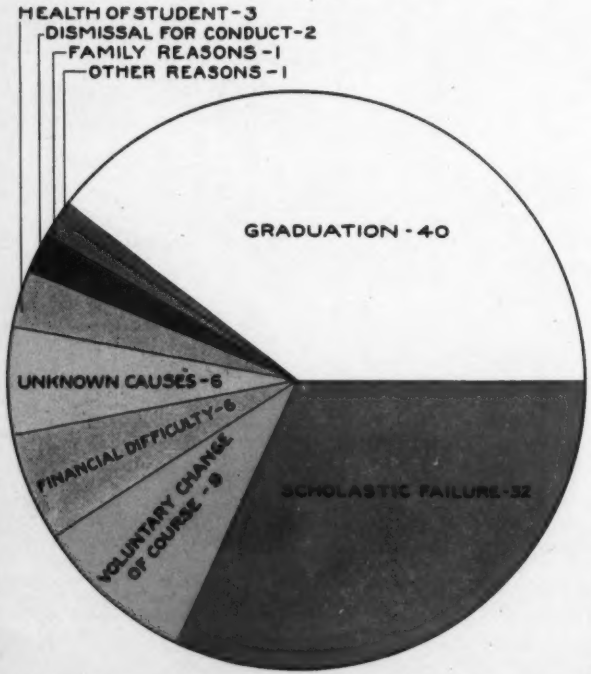
f. The methods employed by a number of institutions to prevent or discourage the unprepared from entering their colleges of engineering have apparently reduced the percentages of elimination and increased the quality of work which they are able to do.

g. In spite of the fact that it is a universally recognized fact that social, athletic and other diversions have increased markedly in the colleges during the last few years, the number of scholastic failures attributed to these causes is very small—4.5 percent of the total causes.

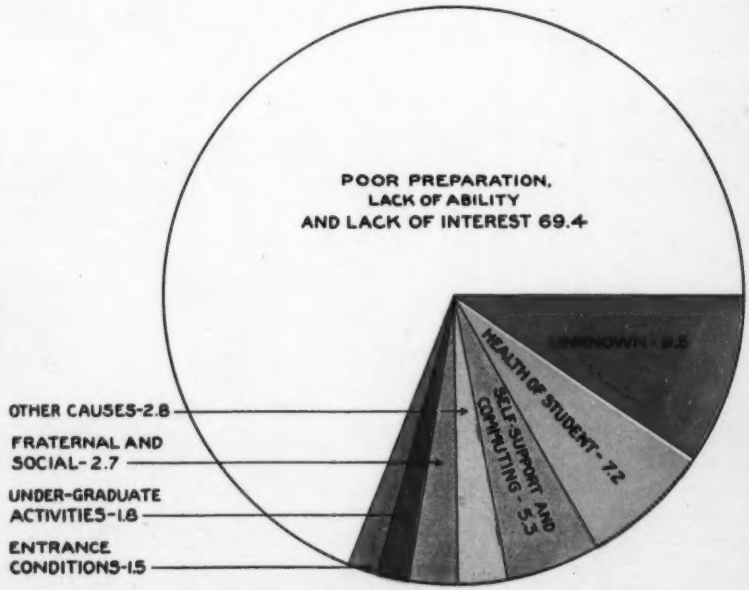
Your committee raises the question: Is or is it not a correct premise to lay down that nearly every student now entering our engineering colleges is endowed with native ability and enough vocational aptitude to undertake and successfully complete the first two years of college work? Is it not true, also, that our scholastic failures are due almost entirely to a lack of preparation in a particular field, namely mathematics?

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—STUDY OF ADMISSIONS AND ELIMINATIONS

CHARTS SHOWING GRADUATIONS, ELIMINATIONS AND CAUSES OF SCHOLASTIC FAILURE OF ENGINEERING STUDENTS AS GIVEN BY MEMBERS OF THE FACULTIES


HEALTH OF STUDENT - 3
DISMISSAL FOR CONDUCT - 2
FAMILY REASONS - 1
OTHER REASONS - 1
GRADUATION - 40
UNKNOWN CAUSES - 6
FINANCIAL DIFFICULTY - 6
VOLUNTARY CHANGE OF COURSE - 9
SCHOLASTIC FAILURE - 32

GRADUATIONS AND ELIMINATIONS PER 100 ENTERING STUDENTS


POOR PREPARATION, LACK OF ABILITY AND LACK OF INTEREST 69.4
OTHER CAUSES - 2.8
FRATERNAL AND SOCIAL - 2.7
UNDER-GRADUATE ACTIVITIES - 1.8
ENTRANCE CONDITIONS - 1.5
UNKNOWN - 9.5
HEALTH OF STUDENT - 7.2
SELF-SUPPORT AND COMMUTING - 5.3

CAUSES OF SCHOLASTIC FAILURE PER 100 CASES

And further, are our engineering students less affected by the diversions and distractions of college life than other students?

SUMMARY.

During this report your committee has raised the following questions:

1. How can the engineering colleges exert a direct and effective influence on the preparatory schools in the way of securing greater emphasis and better instruction in the subjects of the high school curriculum which are fundamental to collegiate study?
2. Is there a need for additional selective methods over and above the present system of admitting on scholastic credits alone?
3. What may be done to bridge the gap between high school and college so that the jar and shock will be less and the achievement of the first year greater?
4. Is, or is it not a correct premise to lay down that nearly every student now entering our engineering colleges is endowed with native ability and enough vocational aptitude to undertake and successfully complete the first two years of college work?
5. Are our scholastic failures due almost entirely to lack of preparation in mathematics, or is this only an index of general unpreparedness for engineering college work?
6. Are engineering students adversely affected in their scholastic work in direct proportion to the known increase in extra-curricula activities on a college campus, or are they largely immune and non-participants in such diversions?

In the matter of the direction of further study of these questions the committee suggests the following:

1. A detailed study by individual colleges of the fundamental reasons underlying the withdrawal of undergraduate students, according to a comprehensive plan worked out by the colleges and the Director of Investigation.
2. An effort to establish a series of tests or examinations for incoming students to the end that the average quality

of incoming students may be objectively tested from time to time. At present we are largely dependent on personal recollections and impressions of older men whose viewpoint and perspective are subject to continuous change.

In this connection it may be remembered that about 8,000 students in 40 colleges were given placement tests in November, 1919 by a Committee of this Society. It may be that six or more years could be saved in this work by utilizing these identical tests at intervals.

For the Committee:
H. H. JORDAN, *Chairman*,
G. W. MUNRO, *Secretary*.

SUMMARY OF DATA ON ADMISSIONS AND ELIMINATIONS OF ENGINEERING STUDENTS. MAY 15, 1925.

METHODS OF ADMISSION.

Of the 116 institutions in the United States which were selected for study, 109 admit students to engineering courses primarily on the acceptance of credentials from accredited high schools. These institutions usually also provide for admission by other methods, including entrance examinations set by the institutions themselves, by acceptance of certificates of the College Entrance Examination Board, acceptance of certificates of the New York Board of Regents, or by acceptance of records of work done in other collegiate institutions.

Seven institutions in the United States do not admit students to engineering courses upon presentation of high school credentials, but require candidates to present certificates of the College Entrance Examination Board, to pass the entrance examinations set by the institution itself, or to have completed one or more years of college work.

The six Canadian institutions studied admit primarily by requiring candidates to present evidence of satisfactory grades in matriculation examinations set by the Provincial educational authorities.

Of 70 institutions supplying data, 53 state that they exercise

TABLE I.

ANALYSIS OF REQUIREMENTS FOR ADMISSION TO ENGINEERING COURSES OF INSTITUTIONS IN THE UNITED STATES AND CANADA.

Type of Institution.	No. of Each Type.	Number of Units in Definitely Specified Subjects.			Number of Units Specified in Mathematics.					Number Requiring.		Specified Units in Science.					Entrance Conditions.		
										Solid Geom.	Plane Trig.	Total.			Physics.	Chemistry.	Permitted.	Not Permitted.	No Statement.
		0–7	7½–9½	10–15	0–2	2½	3	3½	4			0	1	2					
State Universities	38	16	9	13	7	4	23	1	3	24	4	15	18	5	10	1	23	8	7
Land Grant Colleges	20	8	11	1	3	4	10			9		10	10		3		10	6	4
Other State Institutions	6	2	3	1		7	4	1		6		3	2	1	3	1	4	1	1
Privately Endowed Arts Colleges	7	1	5	1	3	4	1	1		2		3	3	1	1	1	3	1	3
Privately Endowed Universities	26	5	8	13	4	1	10	5	3	15	7	9	13	4	7	3	12	3	11
Privately Endowed Poly. Institutes	9		3	6	1	2	3	2	3	8	4		5	4	5	5	5	1	3
Municipal Inst's	2	1		1		1	1			2		1	1				1		1
Military Colleges	3	1	2		1	2				1		2	1					1	2
Totals	111	32	41	31	19	25	52	10	9	67	15	43	53	15	29	11	58	21	32

Total number of units required for admission:
14 units required by 1 institution
14½ units required by 5 institutions
15 units required by 102 institutions
16 units required by 3 institutions

TABLE 1.—*Continued.*

SUMMARY OF ANALYSIS OF ENTRANCE REQUIREMENTS, CONTINUED.

Location of Institution.	No. of Each Type.	Number of Units in Definitely Specified Subjects.			Number of Units Specified in Mathematics.					Number Requiring.		Specified Units in Science.					Entrance Conditions.	
										Solid Geom.	Plane Trig.	Total.			Physics.	Chemistry.	Permitted.	Not Permitted.
		0–7	7½–9½	10–15	0–2	2½	3	3½	4			0	1	2				
New Eng. and Mid. Atlantic States....	36	1	11	24	4	4	12	9	7	27	12	9	21	6	9	6	16	4
Southern States.....	22	10	10	2	3	9	8	1	1	6	1	15	6	1	2		9	7
Mid. Western States.....	32	16	11	5	4	7	21			23		12	17	3	11	2	21	5
Rocky Mountain States.....	13	4	4	5	5		8			8		4	5	4	6	1	9	3
Pacific Coast States.....	8	3	5		3	1	3		1	3	2	3	4	1	1	2	3	2

complete control over requirements for admission to engineering courses, while 17 institutions, or approximately 25 percent, must accept all graduates of high schools approved by the State educational authorities or must keep their entrance requirements in harmony with standards set by those authorities. In the matter of supervision and control in accrediting high schools, 11 institutions report that they exercise such supervision or control, while 53 institutions report that they do not. Six institutions did not report on this question.

Table 1 gives a condensed summary of the scholastic entrance requirements for admission to engineering courses in 111 institutions in the United States, classified both as to types of institutions and as to sections of the country.

Admission to Advanced Standing.

In almost all institutions students are admitted to advanced standing in engineering courses upon the basis of a transcript of the scholastic record achieved in the course or institution from which the transfer is made, and upon the submission of evidence of honorable dismissal. It is the general practice to examine into each case upon its individual merits, the Dean or Committee on Admissions examining the credentials and placing the student in the course at a point deemed proper. In many institutions it is the custom to stipulate that such placement is tentative and that readjustment will be made if the student does not make a satisfactory scholastic record in the subjects to which he is admitted. Many institutions place restrictions upon admissions by transfer and require that the student's record shall have been without any conditions or failures during the preceding academic year, that he shall have stood in the upper third of his class, or otherwise endeavor to prevent the transfer of students whose previous scholastic record has been poor.

Supplementary Admissions, Procedures and Requirements.

Intelligence tests are given in several institutions as a part of the admissions procedure but with a very few exceptions the

intelligence tests score is not used as a ground for refusing admission.

Physical examinations are given in many institutions to all entering students, but only in a few cases—principally the military colleges and those having coöperative courses—is failure to meet certain physical and health standards a ground for refusing admission.

Personal interviews or "appraisals" are a definite part of the admissions procedure of some institutions, principally those which select entering students from among more applicants that can be accommodated. At present very few engineering colleges use the personal interviews as a definite basis for admission, though a number use them for other purposes.

Of 70 institutions answering the question, 59 replied that they do not limit enrollment. Eleven state that enrollment is limited either in engineering courses or in the institution as a whole. Of the eleven which have set a limit on enrollment, three have not reached the limit and hence have not applied the restriction. In six cases the limitation of enrollment is enforced either as to the entire Freshmen Class or as to the institution as a whole, though the enrollment in engineering courses is not equal to the number which could properly be accommodated with present staff and facilities.

In certain institutions admission to engineering courses is restricted by limitations not included in the foregoing statement of entrance requirements. These limitations take the form of refusal to admit students from the lowest third of high school graduating classes, selection of only the best from among applicants whom the institution is not required by law to admit, and the like.

Entrance Conditions.

Fifty-two institutions representing all types and all sections of the country supplied information as to the number of students admitted with entrance conditions in the fall of 1924. The data are summarized in Table 2. It is to be noted that several institutions, while not admitting conditioned students

TABLE 2.

ANALYSIS OF ENTRANCE CONDITIONS.

Institution Number.	Total Freshmen 1924–25.	Total Conditioned Freshmen 1924–25.	Total Students Conditioned in Each Subject.					Units of Math. Required.	Percentage of Freshmen Conditioned.	Percentage of Conditions in Math.
			(a) Math.	(b) Science.	(c) English.	(d) Languages.	Others Where Given.			
1	72	43	13	8	9	13		3	59.7	30.3
2	296	0						3	0.0	
3	88	0						2	0.0	
5	121	0						2½	0.0	
6	85	49	45	12	2	20		3½	57.6	91.8
9	354	106	61	18	5	31		3	30.0	57.5
14	107	4	1		1			2	3.7	25.0
16	212	91	59	18	2	24		3	42.9	64.8
24	90	0						4	0.0	
27	63	0						3	0.0	
28	28	1			1			3½	3.6	0.0
30	85	22	18	4				3	25.9	81.8
31	499	0						3	0.0	
34	110	21	6		1	17		2½	19.1	28.6
35	374	227	212	50				3	60.7	93.4
36	186	2						3	1.7	0.0
38	121	8		1		6	1	3½	6.6	0.0
41	146	84	59	1		24		3½	57.5	70.2
43	140	36	24	3		9		3	25.7	66.7
44	82	0						3	0.0	
46	125	36	15	4	9	8			38.8	41.7
47	149	15	4	6				3	10.6	26.6
49	453	162	120	87				3	35.8	74.1
51	18	0						2½	0.0	
52	102	8	2		3		3	3	7.8	25.0
54	148	71	54	27				3	48.0	76.1
—	50	2	2						4.0	100.0
56	218	75	29	23	13	7		2½	34.4	38.7
57	83	27	26	9	2			3	32.5	96.4
58	28	2	2						7.1	100.0

TABLE 2.—*Continued.*

Institution Number.	Total Freshmen 1924–25.	Total Conditioned Freshmen 1924–25.	Total Students Conditioned in Each Subject.					Units of Math. Required.	Percentage of Freshmen Conditioned.	Percentage of Conditions in Math.
			(*a*) Math.	(*b*) Science.	(*c*) English.	(*d*) Languages.	Others Where Given.			
59	125	46	8	22		1	15	3	36.8	17.4
63	285	8	8					2½	2.8	100.0
64	155	47	41			7		3	30.3	87.3
70	65	15	10	5				3	23.1	66.7
74	220	30	26					2½	13.6	86.7
80	37	0						4	0.0	
81	645	75	74				1	3	11.6	98.7
83	388	83	83		2	6		3	21.4	100.0
86	254	11	5		1	1	4	4	4.3	45.4
87	32	5	2			3		3	15.6	40.0
88	19	5				5			26.3	0.0
91	83	52	35	39				3	62.7	67.3
92	49	7						2	14.3	0.0
97	516	55						3	10.7	0.0
100	66	2	2					2½	3.0	100.0
101	119	0						3½	0.0	
104	167	12					12	2	7.2	0.0
105	306	0						3	0.0	
106	239	95	75	20					39.7	79.0
109	20	0						2½	0.0	
112	145	42	21	3	7	20		3½	29.0	50.0
114	160	24	7	4	6	10		3	15.0	29.2
Totals	8,728	1,706	1,149	364	64	212	36		19.6	67.3

Percentage of Freshmen Entering with Conditions 19.6
Weighted Average, Units of Required Mathematics 2.8
Percentage of Freshmen Entering with Conditions in Mathematics 13.2

Distribution of Conditions	% of Conditioned Freshmen
Mathematics	67.3
Science	21.3
English	3.8
Languages	12.4
Others	2.1
Total	106.9*

* Some Freshmen enter with conditions in more than one subject.

Languages	12.4
Others	2.1
Total	106.9*

* Some Freshmen enter with conditions in more than one subject.

TABLE 3.

EFFECTS OF ENTRANCE CONDITIONS IN MATHEMATICS

Institution Number.	Total Freshmen Fall of 1923–24.	Percentage Having Entrance Condition in Mathematics.	Students Not Conditioned in Mathematics.		Students Conditioned in Mathematics.		Percentage Surviving to Begin Sophomore Year.	
			Began Freshman Year.	Began Sophomore Year.	Began Freshman Year.	Began Sophomore Year.	Not Conditioned in Math.	Conditioned in Math.
16	155	31.0	107	52	48	10	48.6	20.8
30	60	40.0	36	28	24	19	77.8	79.2
35	303	53.8	140	58	163	43	41.4	26.4
41	160	36.2	102	78	58	41	76.4	70.7
43	133	33.1	89	63	44	27	70.8	61.3
46	89	9.0	81	50	8	2	61.7	25.0
49	406	21.7	318	139	88	35	43.7	39.8
70	79	27.8	57	48	22	12	84.2	54.1
112	149	16.1	125	88	24	8	70.4	33.3
Totals	1,534	31.2	1,055	604	479	197	57.2	41.1

to engineering courses, admit them to the courses in Liberal Arts and later transfer them to Engineering when entrance conditions of the Engineering College have been removed. Not including such cases, it is seen that approximately one student in five was not able to meet the specified requirements, and that approximately one student in eight was admitted with conditions in mathematics, a majority of these being in intermediate algebra and solid geometry. The effect of entrance conditions in mathematics as indicated by the relative proportions of students conditioned or not conditioned in mathematics at entrance who survive to begin the Sophomore Year is shown in Table 3. It is also to be noted in connection with the preparation of students for engineering courses, that of the 4,000 students canvassed, but 2.6 percent were in the lowest third of their high school graduating classes. (See Report on Study of Entering Students.)

Methods of dealing with conditioned entering students differ considerably in the various institutions. A number provide courses of sub-collegiate type which do not carry college credit. In several institutions tutoring sections are formed. In others students are required to provide for the removal of entrance conditions as best they may, no provision being made for classes in sub-collegiate work. A number of institutions remove entrance conditions if satisfactory work is done in corresponding college subjects. Most of the colleges require that entrance conditions be removed before the beginning of the sophomore year.

Preparation of Engineering Students.

Table 4 gives the proportion of students preparing in various types of schools. Approximately seven-eighths of the students enrolling in engineering prepared in public high schools. One-eighth of all admissions to engineering courses in 1924–25 were in advanced standing. Table 4 also shows the proportion of male graduates of high schools who were going to college or otherwise continuing their education in 1921–22. It is to be noted that four-tenths of these graduates were going to college and that one-half of them were continuing their

education by going to college or to some other type of institution. Table 4 also shows the ratio of engineering enrollment to the total male enrollment in the colleges in the year 1921–22.

TABLE 4.

STATISTICS RELATING TO GRADUATES FROM PUBLIC HIGH SCHOOLS AND NUMBER OF GRADUATES CONTINUING THEIR EDUCATION IN 1921–22.

Compiled from Bulletin, 1924, No. 7, "Statistics of Public High Schools 1921–22" of the U. S. Bureau of Education.

	Total Number of Students.	Number of Male Students.	
Total number of graduates, 10977 schools reporting	243,648	99,331	
Number going to college	76,588	39,558	
Going to other institutions	34,972	10,063	
Total students continuing their education	111,560	49,621	
Percentage of male students going to college			39.8%
Percentage of male students continuing their education			50.0%

Compiled from Bulletin, 1924, No. 20, "Statistics of Universities, Colleges, and Professional Schools 1921–22" of the U. S. Bureau of Education.

Total number of students in universities, colleges and professional schools	618,555	
Total number of male students in these institutions	402,036	
Total number of engineering students	56,649	
Ratio of engineering students to total male students		14.1%

Preparation of Freshmen Admitted in Fall of 1924.

Public High Schools	87.3%
Parochial High Schools	2.4
Private Preparatory Schools	7.0
Private Tutoring	0.3
One or more years of college, not including admissions to advanced standing	3.0
Ratio of admission in advanced standing to total admissions	12.1

As a part of the study of admissions and eliminations, statements were obtained from the faculties as to the quality of preparation for engineering and of the effect of the quality of preparation upon the work of the engineering colleges. With the exception of schools in the Southern States, it is the con-

sensus of opinion that the quality of preparation has shown a distinct deterioration in the last ten years. In the South it is felt that preparation has improved. The chief defects in preparation are a lack of thorough grounding in the fundamental sciences and English and the inability of the students to think accurately or to study thoroughly. The effect of poor preparation is especially felt in courses in mathematics. The remark is made by one committee that students appear to have been trained to solve easy problems by imitative methods, rather than to solve the problems which require any original thinking or thorough knowledge of fundamental principles. The work of many of the colleges has been seriously hampered, and to an increasing degree, during the first two years of engineering courses by the necessity of segregating poorly prepared students in special sections in which the elementary mathematics is reviewed. An increasing number of students are applying for admission to college without the specified number of entrance units in mathematics. A more extended discussion of this matter is given in the March issue of the *Journal of Engineering Education*.

Selection of Course.

The following table shows the present practice of the colleges in the matter of the time at which students must make a selection of the particular engineering course which they desire to pursue:

Time of Choice of Course.	Number of Institutions.
Beginning of Freshman Year	12
During Freshman Year	1
End of Freshman or Beginning of Sophomore Year	51
During Sophomore Year	9
End of Sophomore or Beginning of Junior Year	24
End of Junior or Beginning of Senior Year	3
Total	100

From replies received to questions it is apparent that the colleges are giving increased attention to the guidance of

students in making their choice of courses of study, although about half of the institutions reporting indicate that they have not as yet taken steps in this direction. The principal methods in use at present are: orientation lectures, engineering problem courses, elementary engineering laboratory courses, informal talks by teachers and others, and advice given through faculty advisors. The following are interesting examples of methods in use:

University of Washington. "During the freshman year no classification of the students into separate departments is made. Throughout the freshman year special efforts are made to assist the student in selecting his department by

(*a*) A course in engineering problems throughout the freshman year, introducing the student to the engineering viewpoint and to the systematic applications of mathematics and physics in engineering problems.
(*b*) A special Freshman Advisor.
(*c*) A series of lectures to freshmen by members of the different departments stating the general scope of the work in each branch of engineering.

Choice of departments is made at the beginning of the sophomore year."

University of Nebraska. Students are assisted in their choice of a particular course in engineering through a Freshman Orientation Course. Saturday mornings from 9 to 12 are devoted to the work. The class meets in one group for five general lectures at regular intervals during the course. On intervening Saturdays the class is divided into sections which meet successively in the several departments. Three mornings are spent by each section in each department. The work of the departments is outlined in lectures, trips are taken through the laboratories, and visits made to nearby engineering works. Moving pictures are also used. All sessions of the course end with a written quiz. Two semester-hours credit are given for the course.

Elimination of Engineering Students.

The numbers of students admitted to and graduated from thirty-eight representative colleges of engineering in the United States and Canada from 1899 to 1924 inclusive are shown in Table 5. All admissions, whether as freshmen or in advanced standing, are included. It is to be noted that approximately 40 percent of the students entering engineering courses graduated from them, and that the proportion of graduations has decreased from 43.5 percent to about 38 percent in a period of twenty-two years.

TABLE 5.

Admissions to and Graduations from Engineering Courses.

Table shows total number of students entering in a given period and total number graduating in a corresponding period four years later.

38 Institutions Represented.

Total number admitted in 1899–00 to 1903–04 inclusive	14,394
Total number graduated in 1902–03 to 1906–07 inclusive	6,257
Ratio of graduations to admissions in per cent	43.5
Total number admitted in 1904–05 to 1908–09 inclusive	22,914
Total number graduated in 1907–08 to 1911–12 inclusive	9,807
Ratio of graduations to admissions in percent	42.8
Total number admitted in 1909–10 to 1913–14 inclusive	26,300
Total number graduated in 1912–13 to 1916–17 inclusive	11,447
Ratio of graduations to admissions in percent	43.5
Total number admitted in 1914–15 to 1918–19 inclusive	31,996
Total number graduated in 1917–18 to 1921–22 inclusive	12,056
Ratio of graduations to admissions in percent	37.6
Total number admitted in 1919–20 to 1920–21 inclusive	21,098
Total number graduated in 1922–23 to 1923–24 inclusive	8,102
Ratio of graduations to admissions in percent	38.4
Grand total, number admitted 1899–00 to 1920–21 inclusive	116,702
Grand total, number graduated 1902–03 to 1923–24 inclusive	47,669
Ratio of graduations to admissions	40.8

Table 6 gives records of the survival of those students who enter regularly, pursue regular courses of study and graduate at the end of the usual prescribed period. These records are for particular classes.

TABLE 6.

STUDENT SURVIVAL.

Survival of Students who Entered Regularly, Pursued Regular Courses of Study and Graduated with their Class.

Students demoted from preceding classes, or admitted in advanced standing are not included.

Institution Number.	Class.	Began Fresh. Year.	Percentage.	Began Soph. Year.	Percentage.	Began Junior Year.	Percentage.	Began Senior Year.	Percentage.	Graduated.	Percentage.
3	1924	67	100	29	43.3	18	26.9	18	26.9	14	20.9
5	1923	51	100	31	60.8	17	33.3	10	19.6	9	17.6
9	1924	350	100	221	63.1	131	37.4	106	30.3	87	24.9
16	1923	207	100	121	58.4	86	41.5	71	34.3	65	31.4
24	1923	83	100	31	37.3	22	26.5	18	21.7	16	19.3
31	1923	711	100	331	46.6	221	31.1	142	20.0	117	16.5
36	1923	277	100	229	82.6	173	62.4	117	42.2	94	33.9
38	1924	103	100	58	56.3	48	46.6	43	41.7	42	40.8
41	1924	201	100	115	57.2	83	41.3	70	34.8	60	29.9
46	1924	160	100	89	55.6	72	45.0	62	38.8	48	30.0
47	1924	214	100	139	65.0	87	40.7	82	38.3	71	33.2
49	1924	284	100	143	50.3	103	36.3	82	28.9	62	21.8
52	1924	79	100	74	93.7	27	34.2	22	27.8	18	22.8
54	1923	103	100	54	52.5	33	32.1	30	29.1	28	27.2
59	1924	122	100	66	54.1	38	31.1	34	27.9	34	27.9
62	1923	92	100	60	65.2	53	57.6	48	52.1	36	39.1
63	1924	141	100	79	56.0	62	44.0	55	39.0	53	37.6
64	1923	70	100	31	44.3	16	22.8	13	18.6	10	14.3
80	1923	21	100	17	81.0	12	57.1	9	42.8	7	33.3
81	1923	751	100	514	68.4	358	47.7	289	39.4	269	35.8
83	1923	351	100	225	64.1	170	48.4	137	39.1	106	30.2
86	1924	83	100	48	57.8	34	41.0	21	25.3	21	25.3
91	1924	59	100	35	59.3	28	47.5	24	40.7	20	33.9
93	1923	141	100	93	66.0	69	48.9	63	44.7	54	38.3
98	1924	191	100	152	79.6	123	64.4	115	60.2	115	60.2
100	1924	65	100	39	60.0	31	47.7	21	32.3	17	26.1
105	1923	170	100	111	65.3	87	51.2	70	41.2	65	38.2
110	1923	142	100	61	43.0	25	17.6	20	14.1	15	10.6
111	1923	435	100	276	63.4	181	41.6	142	32.6	109	25.1
Totals . . .		5,724	100	3,472	60.6	2,408	42.1	1,934	33.8	1,661	28.1

TABLE 7.

Causes of Eliminations of Engineering Students.

Institution Number.	Scholastic Failure.	Health of Student.	Voluntary Change of Course.	Financial Difficulty.	Dismissal for Conduct.	Family Reasons.	Other Reasons.	Unknown Causes.	Total Cases.
5	14	1	2	2	2	3	1	4	29
10	151	21	24	36	13	4		6	255
10	226	19	25	31	11	1			313
10	139	16	16	26	5	1			203
10	128	11	20	25	6	1			191
24	24	5	13	9	4		3	9	67
38	8	2	32	4	2			20	68
41	46	15	41	7		4		17	130
43	12	7	10	7	11	2	3	20	72
46	81	1	1	1		1		27	112
47	20	2	16	3	2	1	4	19	67
52	13	1	3	21	1		1	11	51
54	35	1	25	9			1	4	75
80	7		2	1	4				14
83	177	10	31	6	1	4	5	11	245
86	37	1	18	1	1			4	62
91	8	1	8	5			11		33
94	20	6	11	2	3	9		5	56
98	36	6		3			10	21	76
100	30		11				2	5	48
103	13	1	14	1	1		3	6	39
104	99	5	14	2	6	4	6	20	156
105	60	4	5		5		6	25	105
110	35	3	26	13				26	103
111	61	12	42	28		3	11	6	163
111	51	4	25	18		4	11	7	120
114	17	2	1	1	1		1	3	26
Totals ...	1,548	157	436	262	79	42	79	276	2,879
Percent of total cases...	53.8	5.5	15.1	9.1	2.7	1.5	2.7	9.6	100.0

Percent of total cases...	53.8	5.5	15.1	9.1	2.7	1.5	2.7	9.6	100.0

TABLE 8.

CAUSES OF SCHOLASTIC FAILURE OF ENGINEERING STUDENTS AS ASSIGNED BY MEMBERS OF THE FACULTIES OF THE INSTITUTIONS.

Institution Number.	Entrance Conditions.	Poor Preparation, Lack of Ability or Lack of Interest.	Under-graduate Activities.	Fraternity and Social.	Health of Student.	Self-support and Commuting.	Other Causes.	Unknown.	Total Cases.
24		15	1					8	24
31		44	4	5	13	3	3	9	81
41		21	1		2	1	8	13	46
47		17	2					1	20
54	4	23	1	1	3	1		2	35
83	5	137			18	9	8		177
91		5	1	1		1			8
110		32	1	1				1	35
111		91	1	2	7	7		30	138
111		43		5	5	8			61
111		41		3	1	6			51
Totals...	9	469	12	18	49	36	19	64	676
Percent of total cases...	1.3	69.4	1.8	2.7	7.2	5.3	2.8	9.5	100.0

TABLE 9.

STATISTICS ON ADMISSIONS TO AND GRADUATIONS FROM VARIOUS PROFESSIONAL AND COLLEGIATE COURSES.

Name of Course.	No. of Institutions Reporting.	Period Covered by Reports.	Length of Course in Years.	Admission Requirements.	Total Number Admitted.	Total Number Graduated.	Ratio of Graduations to Admissions in Percent.
Medicine	7	1915 to 1924	4	Min. 2 years College Work	3,252	2,493	76.6
Dentistry	3	1917 to 1924	4	Min. 1 year College Work	1,393	840	60.3
Law	4	1915 to 1924	3	Min. 2 years College Work	2,790	1,644	59.0
Business Administration	1	1916 to 1924	4	Graduation from High School	3,385	2,097	61.7
Business Administration	1	1919 to 1924	2	Graduation from College	1,218	604	50.0
Agriculture	5	1915 to 1924	4	Graduation from High School	4,777	2,626	54.6
Engineering	38	1914 to 1924	4	Graduation from High School	53,094	20,158	37.8

Causes of Eliminations.

Tables 7 and 8 indicate the principal causes of eliminations of engineering students and of their scholastic failure. The data upon which these tables are based were obtained from the records of the several institutions, and indicate the reasons for withdrawal or failure assigned by teachers or administrative officers of the colleges.

Eliminations in Other Collegiate Courses.

A comparison of numbers eliminated from engineering courses and from other professional and collegiate courses is given in Table 9, which was prepared from data furnished by a selected number of institutions.

SUMMARY AND REPORT, PROJECT Aa1

A STUDY OF ENGINEERING STUDENTS AT TIME OF ENTRANCE TO COLLEGE.

JUNE 1, 1925

Data upon which the following report and summaries are based were supplied by means of questionnaire studies carried out through the coöperation of committees of the faculties of institutions which accepted an invitation to undertake the work. The forms used in obtaining and compiling the information are not reproduced but may be obtained from the office of the Director of Investigation, Society for the Promotion of Engineering Education, 33 West 39th Street, New York City. The types and locations of institutions participating in the work are as follows:

State Universities, including Land Grant and Non-Land Grant Institutions	9	Institutions in New England and Middle Atlantic States	14
Privately Endowed Universities	6	Institutions in Southern States	4
State Land Grant Colleges	6	Institutions in Middle Western States	9
Privately Endowed Polytechnic Institutes	3	Institutions in Rocky Mountain States	2
Privately Endowed Ar[illegible] Colleges	1	Canadian Institutions	2
State Military Colleges	2	Hawaiian Institutions	1
State Schools of Mines	1		
Municipal Institutions	1		
Canadian Institutions	2		
Hawaiian Institutions	1		
	32		32

The number of individuals reported upon is 4,079, representing approximately 20 per cent. of the entering class admitted in the fall of 1924. This number of individuals, and the distribution of the institutions are probably such as to make the results a fair sampling of the entire group of entering students, and hence to warrant the drawing of definite conclusions.

The project was carried out under the sponsorship of the Committee on Engineering Students and Graduates:

R. L. Sackett, Chairman,
E. B. Roberts, Secretary,
Edward Bennett,
J. W. Hallock,
G. B. Pegram,
R. I. Rees,
H. P. Talbot.

The report of the committee is given in the following pages. A condensed summary of the results with comments thereon is also given. This summary is very much condensed from the original tabulations which may be consulted at the office of the Director of Investigation.

H. P. HAMMOND,
Associate Director of Investigation.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, REPORT OF COMMITTEE ON ENGINEERING STUDENTS AND GRADUATES. JUNE 1, 1925.

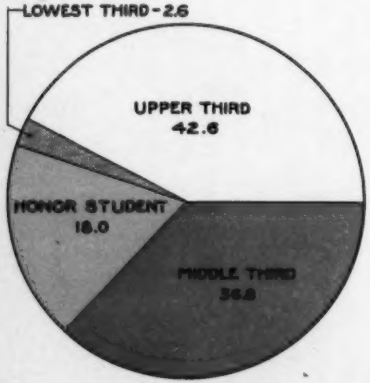
Your Committee conceives its duties to be three-fold: (1) to coöperate and advise with the Director and his staff, (2) to assist in study and interpretation of the data gathered in the studies which have been undertaken, and (3) to consider what may profitably be undertaken as further lines of investigation; and, at a proper time, to consider what actions, if any, the Society and the Colleges of Engineering may take as outcomes of the phase of the Investigation with which the Committee is associated. Your Committee is advised that it need not confine its deliberations or attention strictly to the information gathered in the particular projects undertaken under its sponsorship, but may draw upon evidence gathered in any of the other studies, in so far as they relate to matters connected with student personnel and to problems connected with engineering graduates. It believes further that the in-

formation thus far obtained and to be obtained in the future should not be considered or interpreted narrowly, but that both the studies themselves and their interpretation should be such as to throw light to the greatest possible extent upon the general problems of engineering education.

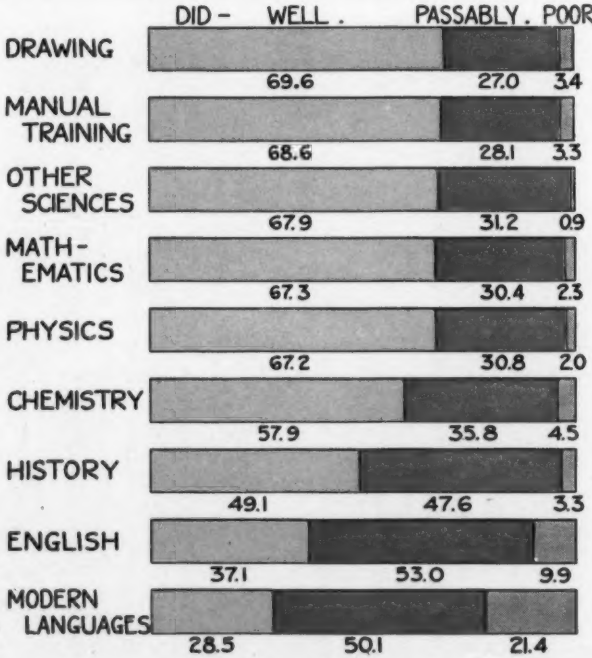
Your Committee's report has been divided into two portions: One relating to engineering students at the time of their admission to college, and the other to graduates of engineering and to former students who did not graduate. The present section of the report deals with entering students. It is based upon the results of a questionnaire study undertaken in the fall of 1924 by a number of committees of the faculties of coöperating institutions at the invitation of the Board of Investigation and Coördination. The study was designed to produce information on the following principal matters: The racial extraction of engineering students; the cultural and educational background of their homes; their secondary school preparation; their mental abilities; and the manner and time at which they decided to go to college, to become engineers, and to pursue a particular course in engineering—these latter with a view to determining the basis on which these important decisions were formed and the manner and extent to which they received valid guidance therein.

The results of the study are based upon returns covering approximately 4,000 individual students attending 32 institutions fairly representative of the various parts of the United States and Canada and of the various types of institutions which offer engineering courses. Since the data is based upon approximately 20 per cent. of all freshmen admitted in the fall of 1924, it is believed to be sufficiently representative to warrant general conclusions as to the entire group of students entering our engineering colleges.

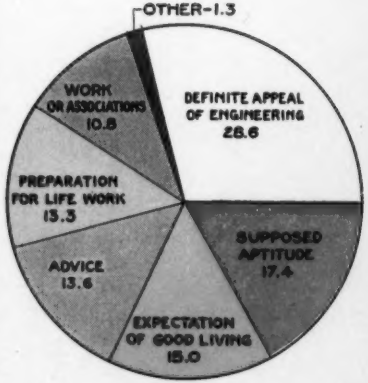
While the time which has been available to your Committee for the study of the data has been short it is felt that some rather definite conclusions can be drawn, though the present report is presented as a report of progress and of preliminary findings and not as a final report on this study.



STUDENTS' STANDING IN HIGH SCHOOL CLASSES



STUDENTS' RECORDS IN HIGH SCHOOL SUBJECTS



BASIS OF DECISION TO STUDY ENGINEERING

Racial Extraction.

From the accompanying tables it is seen that 96 per cent. of our students, 74 per cent. of their parents, and 61 per cent. of their grandparents were born in the United States and Canada. 91 per cent. of the grandparents were born either in the United States and Canada or in countries in the northwestern part of Europe. The remainder, 9 per cent., were natives of countries in southern Europe, of Latin-American countries, Slavic countries, and others. Comparatively few of our students seem to have been derived from the wave of immigration coming in recent years from countries in the southern and eastern parts of Europe. Since it is generally considered that the best of our racial stock is either native-born or derived from countries in northern and western Europe, it seems fair to conclude that our engineering students are of sound racial extraction.

The above figures are for the colleges as a whole. When the figures for particular institutions are studied, it is seen that the variations from the average are large. Several institutions show a percentage of native-born grandparents of 30 or less and a number have less than 50 per cent. of entering students whose parents were born in this country. It is to be noted that institutions in the southern and western states show a higher percentage of native stock than those in the eastern states, and that institutions in rural sections have a higher percentage of students of native extraction than those in the cities.

Students' Home Environment.

The data afforded a number of interesting sidelights as to the cultural and educational environment of our students' homes. Approximately 16 per cent. of the fathers are in the various professions, 29 per cent. are in positions connected with industry, 17 per cent. are farmers, 22 per cent. are in financial and mercantile activities and 15 per cent. are in miscellaneous types of employment, including the service of the public, journalism, and publishing. A rather surprisingly large number, 42.5 per cent. are the owners or proprietors of

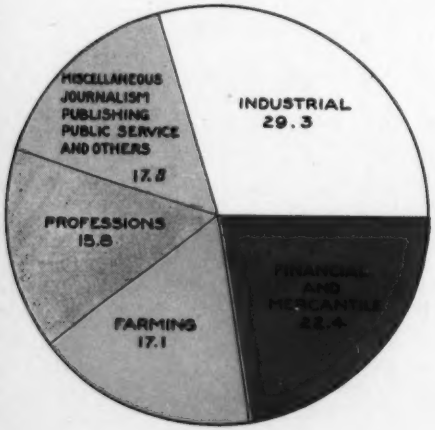
businesses, including the farmers; 28 per cent. are in major or minor executive or supervisory positions; while 19 per cent., a rather large number, are either skilled or unskilled workmen. Only 4 per cent. are engineers. The remaining 6 per cent. are teachers or are in miscellaneous types of positions.

The statistics of the education of the students' parents warrant careful attention. Approximately 13 per cent. of the students' fathers and 5 per cent. of the mothers are college graduates. About 40 per cent. of the parents are graduates of high school. Approximately 40 per cent. of the parents have either a grammar school education or less, and about 15 per cent. of the fathers and 10 per cent. of the mothers have never completed an education extending through grammar school. It would seem fair to conclude that the majority of engineering students come from homes in which there is but a limited knowledge of or contact with higher education, and in particular with engineering education, or from which the students would have much of a background of culture in the broad meaning of that term. The basis upon which students form decisions to go to college and to study engineering, which will be quoted later, seem to bear out this conclusion.

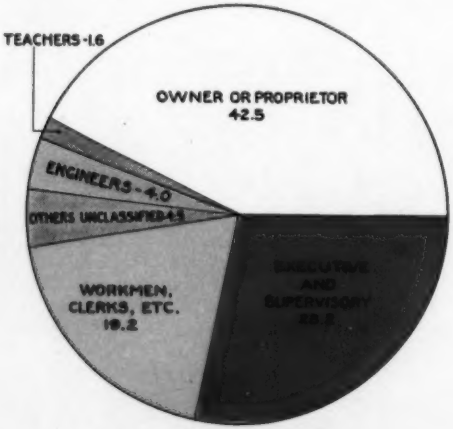
Distances from which the Colleges Draw their Students.

Though there is a rather large proportion of institutions in rural communities represented in the summaries, it is found that one half of the students are drawn from a radius of slightly more than 100 miles. It is also found that about 25 per cent. do or could live at home while attending college and that about 84 per cent. live within the States in which the institutions are located. Only 15 per cent. of the students migrate into other states to pursue engineering courses. About 1.2 per cent. come from foreign countries. It is apparent that our colleges draw most of their students from locations close to the institutions themselves. Some institutions are, indeed, quite local in character—several having median radii from which students are drawn of 10 miles or less.

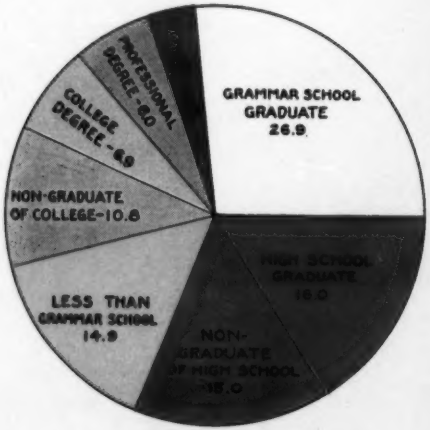
SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—STUDY OF ENTERING STUDENTS



BUSINESS OF STUDENTS' FATHERS



POSITION OF STUDENTS' FATHERS



EDUCATION OF STUDENTS' FATHERS

Earnings of Students before Entering College.

It is interesting to note that a very large proportion of students entering engineering colleges have worked during the year before they entered and that they earned and saved substantial sums. Nine students out of every ten reported that they had done a substantial amount of work before entering college. This seems to have been quite universal among the colleges participating in the study, though in a few the percentage of students who earned was considerably less than the average.

Summary.

From the above it would seem that our students in general are of good racial extraction and that they come for the most part from homes of moderate means and of but a limited cultural and educational background. It may be fair to conclude that our material is fundamentally good but that the broad or general educational aspects of engineering courses cannot be slighted.

Secondary School Preparation.

Since seven eighths of our entering students prepare in the public high schools it is apparent that consideration of preparatory training can be directed principally to those schools. A number of significant facts are presented relative to the kind and quality of this training and to the mental ability of our students. It appears that the colleges of engineering are receiving considerably better than an average selection in point of mental ability, from the product of the secondary schools. Sixty percent. of the entering students were in the honor group or the upper third of their graduating classes, while but 2.6 per cent. were in the lowest third. It appears also that our entering students did well and liked those subjects of the high school curriculum which are considered as fundamental and preparatory to the first two years of engineering courses. Two thirds of the students did well in mathematics, the natural sciences, drawing and manual training and a still larger percentage stated that they had a distinct liking for

such subjects. The percentage of students who did poorly in these subjects and expressed a dislike for them is very small; ranging from less than 1 per cent. to a maximum of 6 per cent. It appears, therefore, that our students, as a whole, possess the natural ability needed successfully to pursue college courses (though not necessarily engineering courses) and that they did excellent work in those high school subjects which form the essential basis of preparation for engineering courses.

When, however, we turn to the quality of this preparation, as the essential foundation for the pursuit of engineering courses, a different picture is presented. Evidence is all too available to show that the preparation for engineering courses given in high school is seriously defective in those elements of definiteness and thoroughness which are so essential in the training of the engineer. The fact that one student in every five admitted to our engineering colleges in the fall of 1924 (See Report of the Committee on Admissions and Eliminations) could not meet the specified entrance requirements, which are not severe, and that such a large proportion—one in eight—could not meet the requirements in mathematics, is an indication of the unsatisfactory condition, as far as the engineering colleges are concerned, of the type of preparation which our students are now receiving. Though legal obstacles to strict enforcement of admission requirements may bear upon some institutions, nevertheless it must be admitted that the manner in which the admission system is executed is a serious factor.

The question may well be raised as to what the engineering colleges and this Society can do to attempt, at least, to ameliorate this condition. Your Committee recommends to the Society and to those charged with the conduct of its present investigation the serious consideration of this important matter.

Educational Guidance of Entering Students.

If the engineering colleges are to function to best advantage and if they are to deal with groups of students whose characteristics are such that they have a reasonably fair chance of

success in pursuing an engineering course, and of success afterward in the field of engineering and of industry, it is apparent that consideration should be given to the means through which students are attracted to the colleges and to the advice and counsel afforded to young men in choosing engineering as a career. The facts obtained in this study throw considerable light on these important matters.

In forming a decision to go to college, students appear to have been influenced by advice of parents, teachers or friends to a smaller degree than might have been expected. Approximately 50 per cent. of the students who replied to the question indicated that the advice had been a factor in their decision to go to college. On the other hand, such reasons as the desire to earn a good living, the desire for a higher education or for general self-improvement were given in a considerably larger percentage of cases. About four tenths of the students indicated that the desire to become an engineer had been an important factor in their decisions. It is significant to note that only 10 per cent. of the students indicated that the advice of preparatory school teachers had been a factor in their decision to go to college. In their decisions to study engineering as preparation for a vocation advice was a still less important factor. Only 24 per cent. of the students indicated that they had based this decision upon the counsel of others, and only 5 per cent. of them indicated that they had profited by the advice of teachers. The outstanding reason for the study of engineering appears to have been its definite appeal; second to that are such reasons as the belief that an engineering training would form the basis of ability to earn a good living and that an engineering course would be a good preparation for almost any line of work.

In the selection of a particular course of study, it is apparent that advice played very little part, since only 10 per cent. of the students indicated that advice of parents, teachers or others had influenced them.

It is also important to note that a majority of students entering engineering courses form their decisions to go to college and to study engineering at an early date. Less than

one fourth of the students reached a decision to study engineering after graduating from high school, whereas slightly more than half formed the decision before entering the last year of high school.

As a check on the validity of the basis of the students' decision to study engineering and to pursue a particular course in engineering, the students were asked to write a short statement of their conception of the field of engineering, of the work of the engineer, and of their understanding of the nature of the particular field of engineering which they had elected to enter. These papers were rated by members of the faculties and gave results as indicated in the tables. It appears that well over half the students have little or no conception or a poor conception of these matters, though they have formed a most important decision on the basis of that conception.

To summarize: It appears that students form their decisions to go to college, to study engineering and to pursue a particular course in engineering at an early period—a majority before reaching the last year of high school; that these decisions are largely the result of individual choice, little influenced by advice; and that they are based upon a very imperfect or faulty understanding of the careers they choose. Your Committee believes that this situation is one to which this Society should give serious thought, and that an earnest effort should be made to find a way to correct the situation which is presented. Is it to be expected that a training so definite and rigorous as that in engineering courses could be followed successfully by students who enter upon it with so little knowledge of their fitness for it? While a number of institutions are now endeavoring to supply information to high school principals, teachers and students as to the nature of engineering work and of the requirements and characteristics of engineering courses, little more than a start seems to have been made in this direction.

It appears to your Committee that this is a distinct field of effort which the engineering colleges should develop without delay. It earnestly commends the discussion of the problem to the Society.

Conclusion.

There are many aspects of the data gathered in this study which are distinctly encouraging. The concrete evidence produced as to the racial extraction of our students, as to their high standing in high school and as to the subjects which they did well and liked in high school seems to point clearly to the conclusion that our student material is fundamentally good and that the young men are on the whole susceptible of development into highly useful members of society. At the same time, the facts adduced relative to the cultural background from which the students go to college are such as to demand the most careful consideration of those upon whom rests the responsibility of planning their educational programmes. It would appear to your Committee that the general educational elements and values in engineering curricula should under no circumstances be given less weight or consideration than the elements of scientific and technological training.

In view of the conclusion that our students as a class considered merely as young men and not primarily as prospective engineers, seem to be of distinctly good quality, serious doubt is raised as to the validity of certain features of an educational programme which less than 40 per cent. of those entering survive successfully to complete. Judged from the viewpoint of the requirements of the engineering profession, it may be quite proper for us to graduate only the proportion we do. But what can be said from the standpoint of the young men whom we admit but later lose for one reason or another?

If our young men on the whole are of sound extraction and good mentality, three chief reasons may be the cause of their elimination from engineering colleges: (1) poor preparation in the high school in those subjects which form the necessary scholastic foundation for engineering training, and lack of that definiteness and thoroughness of training needed to prepare the student to follow a rigorous college course; (2) a lack of effective and valid guidance in selection of career

and college course; (3) failure on the part of the colleges themselves properly to deal with the student after admission. It is believed that all of these elements are important causes of the present high proportion of eliminations. Your Committee's studies touch on this matter chiefly in the second element—that of educational and vocational guidance. Your Committee believes that means of remedying the situation should receive early and most careful consideration of the engineering colleges and of this Society.

R. L. SACKETT, *Chairman*,
E. B. ROBERTS, *Secretary*.

SUMMARY OF DATA, STUDY OF ENTERING STUDENTS.

MAY 15, 1925.

MEDIAN AGE AT ENTRANCE.

The median age given, 18 years and 10.6 months, is the median of the medians reported by the institutions. The minimum median age reported is 18 years and 2 months; the maximum is 19 years and 6 months.

BIRTHPLACE OF STUDENTS AND OF THEIR PARENTS AND GRANDPARENTS.

Several institutions reported all of their entering students native-born. In only one institution was the percentage of foreign-born greater than 15. The minimum percentage of native-born parents was 29. Five institutions reported less than 50 per cent. of native-born grandparents. The majority of these institutions are in large cities. Eight institutions report 90 per cent. or more of native-born parents. All of these institutions are in rural sections and a majority are in southern states. One institution (Canadian) reported that 100 per cent. of its students were native-born.

BUSINESSES AND POSITIONS OF STUDENTS' FATHERS.

The largest single group is the farmers. Second to this come the large and small mercantile concerns, and contracting.

The professional group is divided: engineering, 6.3 per cent.; education, 2.2 per cent.; other professions, 7.3 per cent. It is to be noted that 6.3 per cent. of the fathers are reported as in business of an engineering nature but that only 4.0 per cent. are definitely engineers. In the financial and mercantile group over twice as many fathers are in small concerns as in large ones. The reverse is true of manufacturing concerns. Of the 42.5 per cent. reported as owners or proprietors, 17.1 per cent. are farmers, leaving 25.5 per cent. in other businesses. It is to be noted that the total percentage of fathers in small financial institutions, small manufacturing institutions, small mercantile institutions, insurance, and real estate is 20.6 per cent.; and that the small mercantile group is the largest of these. The positions reported as workmen and clerks are divided as follows: skilled workmen, 13.0 per cent.; unskilled workmen, 2.7 per cent.; clerks, 3.5 per cent. The positions reported as engineers are divided as follows: chief engineer, 1.4 per cent.; supervising engineer, 0.8 per cent.; assistant engineer, 0.5 per cent.; draftsmen, surveyors, etc., 1.3 per cent.

Education of Parents.

College degrees are divided as follows: fathers—professional degrees, 6.0 per cent.; collegiate degrees, 6.9 per cent.; mothers—professional degrees, 0.5 per cent.; collegiate degrees, 4.8 per cent. A larger percentage of the fathers than of the mothers are college graduates—12.9 per cent. as compared with 5.3 per cent., but a smaller proportion are graduates of high school—39.7 per cent. as compared with 41.1 per cent. A considerably larger proportion of fathers than mothers have not graduated from grammar school—14.9 per cent. as compared with 10.0 per cent. The contrasts in the eduation of parents of students in the various institutions are rather striking. One prominent privately endowed eastern university reports that 48.5 per cent. of the fathers and 24.3 per cent. of the mothers hold college degrees, while in another institution only two of the fathers and none of the mothers had attended college.

Communities and Distances from which Colleges Draw Students.

As might be expected, institutions in rural communities draw students more largely from the small towns, the villages, and the country. One institution reported 70 per cent. of its students from communities of less than 5,000 population. Another reported 85 per cent. of its students from cities of over 100,000. The median radius reported was obtained by taking the median of the median distances reported by individual institutions. Only three institutions reported median distances of more than 200 miles. Eight institutions reported median distances of less than 25 miles. Only two institutions reported any considerable proportion of students coming from outside of the state.

Schools in which Students Prepared for College.

A considerable number of institutions reported 95 per cent. of their students as having prepared in public high schools. Only one institution reported a majority preparing in private preparatory schools and only three institutions reported any considerable proportion so preparing.

High School Records.

The returns are very uniform in the proportion of students from the upper third or honor sections of high school graduating classes. No institution shows more than a very small proportion from the lowest third. It is to be noted, however, that 11.5 per cent. of the students did not indicate their standing. It is probable that many of these were not able to state this standing. Some, however, may have failed to state it because of low standing.

The comparatively large proportion of students who reported having done poorly and disliked the subjects of History, English, and Modern Languages forms an interesting comparison with the number of graduates (see Project Aa4) who reported that these subjects were among the most valuable studied in college. The number of students who reported

that they did well and liked high school mathematics also furnishes an interesting comparison with the number of non-graduates (see Project Aa4) who reported this as their chief scholastic difficulty in college.

Basis of Students' Decision to Go to College, to Study Engineering, etc.

Answers to these questions were submitted by the students by checking against a prepared list of reasons. Each student was permitted to indicate more than one reason but was advised to indicate only important ones. The various percentages therefore do not total 100 per cent. The figures were obtained by dividing the total number who indicated each reason by the total number of students canvassed. Since the total of the replies indicating advice of parents, advice of teachers, and advice of friends is but slightly more than 50 per cent. and since a given student may have indicated more than one of these, it appears probable that advice was a factor in the decision to go to college in 50 per cent. of the cases or less. On the same basis, advice was a factor in the decision to study engineering in less than 25 per cent. of the cases. In the choice of a particular course in engineering, advice of parents, teachers, friends, and others was a factor in 10 per cent. or less of the cases. It is obvious that the desire to study engineering was of primary importance in the students' decisions to go to college. 56.8 per cent. of the students indicated that the decision to study engineering was primary and only 30.9 per cent. indicated that it was secondary to the decision to go to college. It is to be noted that in only 9.6 per cent. of the cases has a freshman, shortly after entering, not made a choice of a particular course; this in spite of the fact that only 12 per cent. of the institutions require such a choice at the time of admission.

Students' Conception of Engineering.

The results reported were based on short written statements prepared by the students and submitted to members of the faculty. These were graded under four heads: "Little or

None," "Poor," "Good," "Excellent." It is clear that these ratings are not on an absolute scale but are based merely on the opinions of the members of the faculties who read the papers. Since the ratings were prepared by a considerable number of teachers, it is probably fair to conclude that the results are a reasonably good indication of the quality of the answers and of the understanding of the students. The variations in the returns are not especially large. In two institutions there was some preponderance of ratings under the headings "Good" and "Excellent" and in a few institutions the proportion of ratings reported as "Poor" is rather larger than the average. In the main, however, these variations are not marked.

SUMMARY OF DATA RELATING TO STUDENTS ENTERING ENGINEERING COURSES IN THE FALL OF 1924.
Project Aa1.

The following data are based upon returns from 4,079 students in 32 institutions. The institutions represent the various parts of the country and the several types of institutions which offer engineering courses. The number of individuals is approximately 20 per cent. of all students entering engineering courses as freshmen in the fall of 1924.

(1) Median age of students at time of entrance—October 1, 1924—18 years, 10.6 months.

(2) Birthplace of students and of their parents and grandparents:

Percentage of native-born students	96.2
Percentage of native-born parents	73.6
Percentage of native-born grandparents	60.7
Native countries of grandparents:	
United States and Canada	60.7
Northwestern European Countries	29.4
Southern European Countires	2.6
Latin-American Countries	0.6
Slavic Countries	3.6
Other Countries	3.2

(3) Businesses and positions of students' fathers:

Professions—engineering, education and others	15.8%	Owner or proprietor	42.5%
Industrial—contracting, manufacturing, and transportation	29.4	Executive and supervisory	28.2
Farming	17.1	Workmen—skilled and unskilled, and clerks	19.2
Financial and Mercantile	22.4	Engineers of various ranks	4.0
Journalism, publishing, public service, and unclassified	15.4	Teachers	1.6
		Others, unclassified	4.5

(4) Education of students' fathers and mothers:

	Fathers	Mothers
College or professional degree	12.9%	5.3%
Non-graduates of college	10.8	9.4
High School graduates (including above)	39.7	41.4
Less than full high school course	55.8	55.6
Full grammar school course or less	41.8	38.3
Less than full grammar school course	14.9	10.3
Others, unclassified	3.5	3.3

(5) Size of students' home community:

Rural, including villages up to 500 population	15.0%
Communities of 500 to 5,000 population	24.2
Communities of 5,000 to 25,000 population	22.1
Communities of 25,000 to 100,000 population, or larger	24.5

(6) Distances from which students are drawn to college:

Median radius in miles.....107 (This is the radius of a circle within which 50% of the students have their homes.)

Minimum median radius.... 3 miles

Maximum median radius....275 miles

Percentage of students who do or could live at home	24.8
Percentage whose homes are within the state	83.7
Percentage from United States outside of the state	15.1
Percentage from foreign countries	1.2

(7) Work done, earnings, and savings of students during year preceding their admission to college:

Percentage who worked	90.0
Average per capita earnings	$417.00
Average per capita savings	219.00

Kinds of work done. Figures represent the percentage who reported each kind of work. Some students reported more than one kind.

Farming	13.7%
Selling, office boy work, messenger service, etc.	29.6
Building construction, operating engines or automobiles, repair work, and other varieties more or less closely associated with engineering	49.6
Other varieties	7.1

(8) Schools in which students prepared for college:

Public high schools (85.8% graduates, 1.4% non-graduates)	87.2%
Parochial schools	2.4
Private preparatory schools	6.9
Private tutoring	0.3
One or more years of college (does not include students admitted to advanced standing)	3.0
Ratio of students admitted to advanced standing in engineering courses to total admissions in 1924–25, including transfers from other departments of the same institution, transfers from other engineering colleges, and admissions to advanced standing from other collegiate courses	12.1
Ratio of admissions in advanced standing to freshman admissions	13.7

(9) High school records of entering students:

Honor students and those in upper third of class	60.6%
Students in middle third of class	36.9
Students in lowest third of class	2.6

(10) Records and preferences of students in high school subjects:

	Did well.	Did passably.	Did poorly.	Liked.	Indifferent toward.	Disliked.
Mathematics	67.3	30.4	2.3	84.1	12.5	3.4
Physics	67.2	30.8	2.0	85.7	12.0	2.3
Chemistry	59.7	35.8	4.5	76.0	17.9	6.1
Other Sciences	67.9	31.2	0.9	77.4	19.4	3.2
Manual Training	68.6	28.1	3.3	77.2	17.7	5.1
Drawing	69.6	27.0	3.4	81.3	14.0	4.7
History	49.1	47.6	3.3	51.3	35.2	13.5
English	37.1	53.0	9.9	33.4	42.5	24.1
Modern Languages	28.5	50.1	21.4	20.8	35.6	33.6

(11) Basis of students' decision to go to college: (Students were permitted to indicate more than one reason.)

Advice of parents	32.9%
Advice of teachers	10.1
Advice of friends and others	10.4
Influence of fraternities, college alumni, athletics, etc.	9.0
To be enabled to earn a good living	47.4
To become an engineer	41.6
To obtain a higher education	36.7
For general self-improvement	21.5
Vague desire "to go to college"	7.3
Other reasons	1.3

(12) When decision to study engineering was formed:

After graduation from high school	23.1%
During last year of high school	26.7
Before last year of high school	50.2

(13) Basis of decision to study engineering:

Advice of parents	13.6%
Advice of teachers	4.8
Advice of friends and others	5.8
Work done or associations formed therein	19.2
Definite appeal of engineering work	50.9
Supposed aptitude for engineering	31.0
To be enabled to earn a good living	26.6
Belief that engineering course is good preparation for many lines of work	23.6
Other reasons	2.3

(14) Basis of choice of particular course in engineering:

No choice made	9.6%
Advice of parents, friends or others	10.6
Work done or associations formed therein	18.0
Definite appeal of the work	65.9
Supposed good opportunities in the field	19.7
Reputation of department of the institution	3.4
Haphazard choice	8.8

(15) Students' conception of engineering as evidenced early in freshman year:

Little or none	18.7%	
Poor	37.9	56.6%
Good	30.5%	
Excellent	12.9	43.4%

MINUTES OF THE COUNCIL MEETINGS HELD AT UNION COLLEGE, SCHENECTADY, N. Y. JUNE 17, 18, AND 19, 1925.

Members present: D. S. Anderson, G. C. Anthony, Edw. Bennett, F. L. Bishop, W. E. Brooke, M. E. Cooley, H. S. Evans, F. A. Fish, A. M. Greene, Jr., E. A. Hitchcock, D. C. Jackson, H. H. Jordan, M. S. Ketchum, R. S. King, Wm. T. Magruder, Hugh Miller, E. B. Norris, G. B. Pegram, A. A. Potter, W. G. Raymond, C. F. Scott, F. E. Seavey, G. C. Shaad, A. N. Talbot, F. E. Turneaure, P. F. Walker, W. E. Wickenden, and W. O. Wiley.

The following actions were taken:

1. The invitation of the State University of Iowa to hold the thirty-fourth annual meeting at that institution was accepted. Invitations were also received from the Ohio State University, the University of Wisconsin, the University of Kansas, and from the American Society of Mechanical Engineers to meet with them next year at San Francisco.

2. On the recommendation of the Board of Investigation and Coördination Charles F. Scott was re-elected as a member of that Board for a period of five years.

3. The report of Charles F. Scott, Chairman of the Board of Investigation and Coördination, was read and accepted.

4. The applications for membership of the Chicago Technical College and of the Educational Department of the Edison Electric Illuminating Company of Boston were presented and action deferred.

5. The question of the intelligence tests which L. L. Thurstone has been selling to anyone interested was presented to the Council. Upon motion the Council declined to endorse these tests. After consideration by the Council, this matter was referred to a committee to consider and to recommend action. The members of this Committee are M. S. Ketchum, Chairman, P. F. Walker, and W. T. Magruder.

6. Regarding the question of interference with collegiate associations of state universities, it was the sense of the Council that the Society carries on investigations and presents facts so collected to institutions but that the Society does not try to dictate the policy of any institution.

7. Last year the Council voted to hold one session of this meeting at Rensselaer Polytechnic Institute. President Potter explained that the reason this action was not carried through was due to the fact that the Rensselaer Polytechnic Institute desires to entertain the Society there at some future time and it was not ready for a meeting at this time.

8. The appointment of S. A. Moss on the Committee on Symbols and Abbreviations of the American Engineering Standards Committee was approved.

9. F. L. Bishop was appointed a representative of this Society on the American Council on Education for a term of three years.

10. The Council voiced its approval of a National Museum of Engineering.

11. It was the sense of the Council that this Society is opposed to any classification of engineering colleges at the present time.

12. The Council referred to the Executive Committee with power to act the following resolution received from the Division of Deans and Administrative Officers:

> The Division of Deans and Administrative Officers votes unanimously to request the officers of next year to place a full day without interference for the meeting of this Division and that no other activities be scheduled for that day.

13. A committee was authorized to be appointed by the president of the Society to report on the relation between technical institutes and the Society; this committee to make its report at the meeting of the Council at the next annual meeting of the Society.

14. W. G. Raymond, Chairman, presented the report of the Committee on the Revision of the Constitution. This was

acted upon section by section and the final form, as per attached copy, adopted.

15. Dean P. F. Walker reported on the question of industrial engineering. This report was referred back to the Committee for further consideration—a report to be made at the next annual meeting.

16. The report of the Treasurer was read and accepted. (This will appear in the minutes of the regular meetings.)

17. The report of the Treasurer relating to the Carnegie Fund was read and ordered printed.

18. The following memorial resolutions were adopted and ordered spread on the minutes of the Council meetings:

> During the past year this Society has met with the loss of four of its past presidents to whom the organization owes the greatest debt of gratitude for their services, one as founder, all as administrators and builders of engineering education.
>
> Men of sterling character, men whose influence will survive long after the memory of them shall have ceased.
>
> Mansfield Merriman, founder, President in 1895–96, American pioneer of writers on mechanics, an exponent of ideals in teaching, faithful servant of his fellow men.
>
> Thomas Corwin Mendenhall, President in 1898–99, brilliant physicist, inspiring teacher, investigator and director of the U. S. Coast and Geodetic Survey, college president.
>
> Fred Walter McNair, president in 1904–05, mathematician, scientist, college president, one of the most earnest and intelligent promotors of the Board of Investigation and Coördination, educator, lover of youth, and a rare manifestation of the God love in man.
>
> John Filmore Hayford, president in 1918–19, and Vice-president during 1917–18, scientist, world renowned in geodetic investigation, a rare teacher and executive, beloved by all.
>
> Therefore, as an expression of our appreciation of the character and service of these leaders in engineering education, the Secretary is directed to spread these minutes on the records of the Society.
>
> Committee:
>
> G. C. Anthony, F. E. Turneaure, W. G. Raymond.

19. The following budget for 1925–26 was adopted:

Receipts:

Individual dues		$ 7,000.00
Institutional dues		1,150.00
Back dues		475.00
Advertising		2,000.00
Sale of publications		1,000.00
		$11,625.00

Disbursements:

A.	1925 meeting at Union College	$ 500.00	
B.	Journal of the Society, XVI	5,850.00	
C.	Committee Expenses	150.00	
D.	Secretary's honorarium	1,000.00	
E.	Clerical assistance	2,200.00	
F.	Sundry Printing	300.00	
G.	Postage and expressage	200.00	
H.	Telephone and telegraph	50.00	
I.	Office supplies	50.00	10,300.00
	Estimated surplus		$ 1,325.00

20. Twenty-nine applicants were recommended to the Society for election.

21. Dean G. B. Pegram presented the following report for the Committee on Dues and Subscriptions which had been appointed at an early meeting of the Council:

Whereas the indebtedness of the Society appears to be about $2,300 in excess of the funds available to meet this indebtedness, a condition that results largely from the discontinuance in the present year of the one dollar assessment of several previous years it is recommended that the following steps be taken to obtain additional funds for the Society:

I. Resolved, That the Executive Committee be authorized to solicit from institutional members sustaining subscriptions in the amount of $15 in addition to the dues which shall be, as heretofore, $10.

II. Resolved, That the Executive Committee be authorized to solicit subscriptions from individual members of the Society toward paying off the accumulated indebtedness.

III. Resolved, That for the year 1925–26 an assessment of $1 be levied on each individual member, except new members joining within the year.

The Committee further recommends the following action:

Resolved, That the provisions of the present Constitution as to dues shall remain unchanged but that they be transferred from the Constitution to the By-Laws of the Society.

The report, with its resolutions, was adopted.

Respectfully submitted,

F. L. BISHOP,
Secretary.

MINUTES OF THE THIRTY-THIRD ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, UNION COLLEGE, SCHENECTADY, N. Y., JUNE 17–20, 1925.

The thirty-third annual meeting of the Society for the Promotion of Engineering Education was held at Union College, Schenectady, N. Y., June 17 to 20, 1925. The meetings were held in the Union College Chapel. Registration headquarters were in the Engineering Building. There were 333 members and guests registered. President A. A. Potter, Dean of the Schools of Engineering, Purdue University, presided.

On Tuesday, June 16, and Wednesday, June 17, a number of conferences and visits of inspection were held. Visits were made to the General Electric Company, to the American Locomotive Works, and to the Adirondack Power and Light Company at Cranesville, N. Y.

The conference on Research was held in the Research Building of the General Electric Company with President Potter presiding. The following men lead the discussion: W. R. Whitney, Director of Research, General Electric Company; E. H. Colpitts, in charge of the Research Laboratories, Bell System; A. E. White, Director of Research, University of Michigan; Milo S. Ketchum, Director, Engineering Experiment Station, University of Illinois; R. A. Seaton, Director, Engineering Experiment Station, Kansas State Agricultural College; J. B. Whitehead, Dean, Faculty of Engineering, The Johns Hopkins University; Farley Osgood, President, American Institute of Electrical Engineerings.

The Division of Deans and Administrative Officers met in an all-day session in the Engineering Building of Union College with Chairman H. S. Boardman, Dean, College of Engineering, University of Maine, presiding. Mr. H. P. Ham-

mond, Associate Director of Investigations, gave a report of the work of investigation which the society is now undertaking. Among other things discussed was the issuance by the Society of a small booklet for the guidance of high school students. No definite action was taken but it was the consensus of opinion that such a book should be issued by the Society, the material of which should be prepared by a committee, the style of presenting it to the public turned over to someone who is familiar with that type of work. This could then be sold to institutions at a nominal cost and they in turn could distribute it as they saw fit.

Upon the announcement of Ira N. Hollis' retirement as President of Worcester Polytechnic Institute, it was unanimously carried that he be made a member of this Division as long as he lives.

The following resolution was presented to the Council of the Society by the Division:

The Division of Deans and Administrative Officers voted unanimously to request the officers of next year to place a full day without interference for a meeting of this Division. They request in the vote that no other activities be scheduled for that day.

This resolution was presented to the Council of the Society and upon motion was referred to the Program Committee with power to act.

The teachers of English held two conferences, one on Wednesday, June 17, with W. Otto Birk, University of Colorado, presiding, and the other on Saturday, June 20, with Sada A. Harbarger, The Ohio State University, presiding. A report of these conferences will appear in one of the later numbers of the Journal.

Chairman J. W. Roe, New York University, presided at the conference of teachers of Industrial Engineering. At this conference the following papers formed the nucleus of the discussion: "The Extension of Education in Engineering Management to Fields Other than Factory Production" by C. W. Beese, The Pennsylvania State College; and "What is the

Real Objective of Courses in Industrial Engineering?" by L. P. Alford, Editor, Management and Administration.

The conference of teachers of Electrical Engineering was held at the General Electric Company's plant and H. E. Dyche, University of Pittsburgh, was chairman of the meeting. The subject of this conference was "Research as an Aid to Teaching." Dugald C. Jackson, Massachusetts Institute of Technology, presented the subject from the standpoint of education, and L. A. Hawkins, Chief Engineer of Research of the General Electric Company, presented the industrial viewpoint. Following the discussion, the group visited the works of the General Electric Company.

MINUTES OF THE REGULAR SESSIONS.

Thursday, June 18, 1925.

The thirty-third annual meeting of the Society was called to order at 10:00 A.M. by President A. A. Potter, Dean, Schools of Engineering, Purdue University. In the absence of Charles A. Richmond, President of Union College, E. W. Rice, Chairman of the Board of Directors of the General Electric Company, welcomed the members and guests to Union College and to Schenectady. President Potter responded for the Society. The President appointed the following members of the Committee on Resolutions: J. W. Votey (Vermont), *Chairman*, C. F. Duffey (Porto Rico), and H. V. Carpenter (Washington).

The Chairman of the Board of Investigation and Coördination, Charles F. Scott, Yale University, reported for that body. This report was followed by the report of the Associate Director of Investigations, H. P. Hammond. These two reports outlined in general the work of investigation which is being conducted and were followed by detailed reports by the Committee on Admissions and Eliminations, H. H. Jordan, University of Illinios, *Chairman;* the Committee on Engineering Students and Graduates, R. L. Sackett, The Pennsylvania State College, *Chairman*; the Committee on Graduates of Engineering and Former Students who did not graduate, R.

I. Rees, American Telephone and Telegraph Company; the Committee on Services Rendered by and Facilities of the Colleges of Engineering, E. H. Rockwell, Rutgers University, *Secretary.*

These reports were illustrated by colored charts and graphs which were later hung on the walls for the information of the members.

Second Session, Thursday, June 18, 2:00 P.M.

The second session was called to order by President Potter at 2:00 P.M., and the Director of Investigations, W. E. Wickenden, was introduced. Mr. Wickenden has been making a study of engineering education in Europe as suggested by Dr. Pritchett in the original discussion of the project. Mr. Wickenden spoke "as one who is in the midst of a journey rather than one who has completed it" and will later present his material in a form which can be printed in the Journal of Engineering Education. He spoke "impressionally rather than give the evidence that is needed to support some of my observations."

The report of the Committee on Teaching Personnel was presented by the Chairman, C. H. Warren, Yale University. C. V. Mann of the University of Missouri presented the work which had been done by that institution in connection with this report. A. C. Jewett of the National Industrial Conference Board presented a report of the work which that body has undertaken in connection with the investigation by this Society. C. E. Seashore, State University of Iowa, a member of the Board of Investigation and Coördination, reported on the results of the placement examinations and the study of elimination of engineering students at that institution. This report was followed by a paper by G. W. Munro describing the work in this field which they are doing at Purdue University.

Discussion.

Third Session, Friday, June 19, 1925.

The third session was called to order by President Potter at 10:30 A.M., due to the fact that the institutional delegates had

held a meeting in the Engineering Building of Union College at 9:30 A.M.

Mr. Wickenden continued the report of his work which had been scheduled for the round table the previous evening but which had to be postponed on account of the entertainment features. Following this report the subject "The Relation of Engineering Education to Industry" was discussed by Sam A. Lewisohn, Adolph Lewisohn & Sons, New York City; Ira N. Hollis, President, Worcester Polytechnic Institute; F. C. Pratt, Vice President, General Electric Company; and A. I. Lipetz, Consulting Engineer, American Locomotive Company.

The Report of the Secretary was read by title and ordered printed in the Journal. The report of the Treasurer, W. O. Wiley, was read and accepted and ordered printed in the Journal. Ira N. Hollis introduced Ralph Earle to the Society as the new President of Worcester Polytechnic Institute. The Nominating Committee made the following report which was unanimously accepted:

For President:

George B. Pegram, Dean, School of Mines, Engineering and Chemistry, Columbia University.

For Vice Presidents:

H. V. Carpenter, Dean, College of Mechanic Arts and Engineering, State College of Washington;

F. P. McKibben, Professor of Civil Engineering, Union College.

For Secretary:

F. L. Bishop, Dean, Schools of Engineering and Mines, University of Pittsburgh.

For Treasurer:

W. O. Wiley, John Wiley & Sons, 440 Fourth Avenue, New York City.

For Members of the Council for three years:

C. H. Mitchell, Dean, School of Engineering, University of Toronto;

R. I. Rees, Western Electric Company, 195 Broadway, New York City;

J. A. Hunter, Professor of Mechanical Engineering, University of Colorado;

B. M. Brigman, Dean, School of Engineering, University of Louisville;

W. C. Hoad, Professor of Sanitary and Municipal Engineering, University of Michigan;

G. M. Braune, Dean, School of Engineering, University of North Carolina;

C. V. Mann, Professor of Engineering Drawing, University of Missouri.

The President-Elect, George B. Pegram, was escorted to the platform where he was introduced to the Society by President Potter.

Fourth Session, Friday, June 19, 2:30 P.M.

The fourth and last session of the convention was called to order by R. S. King, Vice-President of the Society. W. C. John, United States Bureau of Education made a report on the Attendance at Engineering Schools. The meeting was then turned over to the discussion of Junior Colleges lead by G. F. Zook, Assistant to the Commissioner of the United States Bureau of Education; LeRoy W. Clark, Rensselaer Polytechnic Institute; and Wm. T. Magruder of The Ohio State University.

H. S. Boardman, Chairman of the Division of Deans and Administrative Officers, presented the report of the conference of that group. J. W. Roe, Chairman of the Committee on Industrial Engineering, reported the results of that conference. H. E. Dyche, Chairman of the Committee on Electrical Engineering, reported for that group; and Miss Sada A. Harbarger reported the results of the conferences on English.

The Committee on Resolutions reported as follows. This report was accepted by a rising vote.

The Society for the Promotion of Engineering Education feels it both an honor and a pleasure to express its sincere appreciation of the cordial courtesy shown by the administration of Union College in placing at its service the splendid facili-

ties of their institution; and to the members of the Faculty of Union College and to all others who have done so much to give the personal touch needed to ensure the success of this Convention.

It desires also to thank the General Electric Company, the American Locomotive Company and the Adirondack Light and Power Company for the opportunities given to the members of the Society to visit their plants; and especially to the General Electric Company and to the Alumni among its staff for the hospitality and entertainment provided at the unique Alumni Dinner, not forgetting in this connection the histrionic endeavors of some of the juvenile members of our own Society.

The members of the Society extend their sincere thanks to the ladies of the Local Committe for the entertainment and companionship so much enjoyed by the visiting ladies.

Those of us who are so fortunate as to be present at this meeting will carry home lasting impressions of a most delightful time spent on the beautiful campus of Union College.

J. W. VOTEY,
H. V. CARPENTER,
C. F. DUFFEY.

The committee appointed to draw up resolutions on the death, during the year, of four of our Past-Presidents, presented the report. (This report is printed in this number in the Minutes of the Council Meetings.) The Society received this report by standing in a silent tribute to the memories of these men who had so faithfully served the Society.

The Committee on the Revision of the Constitution and By-Laws of the Society made their final report. W. G. Raymond, State University of Iowa, Chairman of the Committee, presented the report and explained in detail the changes made. The Constitution and By-Laws as presented by the Committee were unanimously adopted by the Society and will be printed in the forthcoming year book of the Society.

President Potter announced that the 1926 meeting of the Society would be held at the State University of Iowa, Iowa City, in June, the exact time to be determined later.

Twenty-eight individual and one institutional members were elected to membership.

Annual Dinner, Friday, June 19, 7:00 P.M.

At the annual dinner given in the Van Curler Hotel, George B. Pegram, Vice-President 1924–25, President-Elect 1925–26, presided. Before introducing the speaker, Dean Pegram announced that the President of the United States had given official recognition to the Society for the Promotion of Engineering Education by appointing the Secretary, F. L. Bishop, as delegate to the first Pan-American Highway Conference to be held at Beunos Aires in October.

President A. A. Potter gave his Presidential Address on "The Engineering College—Its Opportunity for Service." This was the first presidential address of the Society to be broadcast. Professor F. P. McKibben made a few remarks and the thirty-third annual meeting adjourned sine die.

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